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Catalog No. 4890407-02
Issued: July 1980

# ATR-100 SERIES

# RECORDER/REPRODUCER

# VOLUME 1

OPERATION AND MAINTENANCE

AMPEX CORPORATION
AUDIO-VIDEO SYSTEMS DIVISION

Catalog No. 4890407-02
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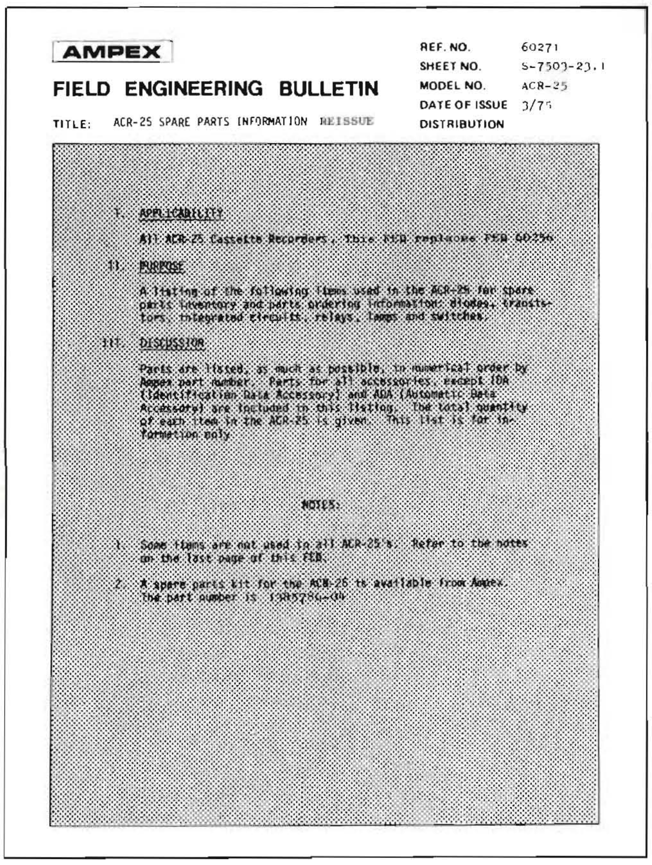
# FOR ADDITIONAL TECHNICAL INFORMATION

## FIELD ENGINEERING BULLETIN SERVICE



AMPEX

FIELD ENGINEERING BULLETIN

TITLE: ACR-25 SPARE PARTS INFORMATION REISSUE

REF. NO. 60271
SHEET NO. S-7503-23.1
MODEL NO. ACR-25
DATE OF ISSUE 3/75
DISTRIBUTION

I. APPLICABILITY

All ACR-25 Cassette Recorders. This FEB replaces FEB 60256

II. PURPOSE

A listing of the following items used in the ACR-25 for spare parts inventory and parts ordering information: diodes, transistors, integrated circuits, relays, lamps and switches.

III. DISCUSSION

Parts are listed, as much as possible, in numerical order by Ampex part number. Parts for all accessories, except IDA (Identification Data Accessory) and ADA (Automatic Data Accessory) are included in this listing. The total quantity of each item in the ACR-25 is given. This list is for information only.

NOTES:

1. Some items are not used in all ACR-25's. Refer to the notes on the last page of this FEB.
2. A spare parts kit for the ACR-25 is available from Ampex. The part number is [illegible]

THE AMPEX AUDIO-VIDEO SYSTEMS DIVISION'S TECHNICAL SUPPORT GROUP PUBLISHES FIELD ENGINEERING BULLETINS (FEBs) DESCRIBING APPROVED EQUIPMENT MODIFICATIONS, SPECIAL TOOLS AND ACCESSORIES PLUS INFORMATION ON IMPROVED OPERATING AND MAINTENANCE TECHNIQUES.

TO RECEIVE THESE BULLETINS, SEND US THE FOLLOWING INFORMATION:

| | | |
|---|---|---|
| Owner's Name | Owner's Address | Model No. |
| Serial No. | Dealer's Name | Dealer's Address |
| | Date of Purchase | |

IN THE UNITED STATES TO:

AMPEX CORPORATION
Audio-Video Systems Division, Technical Support Group
401 Broadway, Mail Stop 3-46
Redwood City, California 94063

OUTSIDE UNITED STATES TO:

YOUR NEAREST SALES AND SERVICE COMPANY

(ADDRESSES ON REAR OF THIS PAGE)

## TRAINING SERVICES

TECHNICAL (MAINTENANCE) TRAINING ON THIS AND OTHER AMPEX VIDEO, AUDIO, DISC AND INSTRUMENTATION PRODUCTS IS OFFERED ON A SCHEDULED BASIS AT CORPORATE HEADQUARTERS IN REDWOOD CITY, CALIFORNIA AND AT HEADQUARTERS EUROPEAN AREA IN READING, ENGLAND. FOR FURTHER INFORMATION REGARDING THIS TRAINING, PLEASE CONTACT YOUR LOCAL AMPEX SALES OFFICE.

# SAFETY AND FIRST AID SUGGESTIONS

Regardless of how well electrical equipment is designed, personnel can be exposed to **dangerous electrical shock** when protective covers are removed for maintenance or other activities. Therefore, it is incumbent on the user to see that all safety regulations are consistently observed and that each individual assigned to the equipment has a clear understanding of first aid related to electrical hazards.

In addition, the following safety practices must be followed:

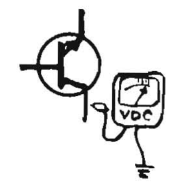

**1** Do not attempt to adjust unprotected circuit controls or to dress leads with power on.

**2** Do not touch heavily loaded or overheated components without precaution to avoid burns.

**3** Do not assume that all danger of electrical shock is removed when power is off. Charged capacitors can retain dangerous voltages for a long time after power is removed. These capacitors should be discharged through a suitable resistor before any circuit points are touched.

**4** Always avoid placing parts of the body in series between ground and circuit points.

**5** Remember that some semiconductor cases and solid-state circuits carry high voltages.




**6** Don't take chances. Be fully trained. Ampex equipment should be operated and maintained only by fully qualified personnel.

If someone seems unable to free himself while receiving an electrical shock, **turn power off** before attempting to render aid. A muscular spasm or unconsciousness can make a victim unable to free himself from the electrical power.

**WARNING**

DO NOT
TOUCH VICTIM OR HIS CLOTHING BEFORE
POWER IS REMOVED OR YOU MAY ALSO
BECOME A SHOCK VICTIM

If power cannot be removed immediately, **very carefully** loop a length of dry nonconducting material (such as rope, insulating material, or clothing) around the victim and pull him free of the power. Carefully avoid touching him or his clothing until free of power. Immediately start the appropriate first aid procedures.

# TABLE OF CONTENTS

# TABLE OF CONTENTS (Continued)

# TABLE OF CONTENTS (Continued)

# TABLE OF CONTENTS (Continued)

## TABLE OF CONTENTS (Continued)



## VOLUME 2

## LIST OF ILLUSTRATIONS (Continued)

## LIST OF TABLES (Continued)

# SECTION 1
# GENERAL INFORMATION

This manual provides operation and maintenance instruction for the models ATR-101 (full track), ATR-102 (2 track), ATR-104 (4 track), and ATR-102S (European) Recorder/Reproducers, Ampex Part Nos. 4010350 (4010380), 4010351 (4010381), 4010352 (4010384), and 4010353 (4010383), respectively. Ampex part numbers in parentheses indicate ATR-100 series units without cabinets.

## 1-1. DESCRIPTION

The ATR-100 series Recorder/Reproducers are professional quality audio tape recorder/reproducers that use 1/4-inch (6.4 mm) or 1/2-inch (12.7 mm) wide magnetic tape on EIA or NAB reels up to 14 inches (35.56 cm) in diameter. The recorder/reproducer can operate in either the NAB or IEC equalization standard at any two/four speeds selected from the following speeds: 3.75, 7.5, 15, and 30 in/s (9.5, 19.05, 38.1 and 76.2 cm/s).

A plug-in-type head assembly permits easy conversion between one- and two-channel operation using 1/4-inch tape, or four-channel operation using 1/2-inch tape. The system is available in five different mounting configurations: cabinet, cabinet mounted on a roll-around pedestal, fixed-rack mount, slide-rack mount, and portable case.

The recorder/reproducer does not incorporate a capstan pinchroller but controls tape movement in all modes of operation while under capstan and reel servo control. The capstan servo controls speed and direction while the reel servo maintains dynamically constant tape tension in all modes of operation.

The basic system incorporates such standard features as an electronic tape timer, Sel-Sync*, PURC (Pick-up Recording Capability), dynamic braking, ceramic tape guides, and ferrite heads. The tape timer displays in hours, minutes, and seconds (or minutes, seconds, and tenths of seconds by changing a jumper) the distance the tape has moved from a zero reference point. The Sel-Sync feature permits the recording of added channels in perfect synchronization with previously recorded channels. The PURC feature eliminates the problem of overlaps and holes in recordings when inserting (dubbing) new material within previously recorded programs. The system does not have mechanical brakes, but incorporates dynamic braking to control all reel braking functions including stopping tape motion when power is removed.

The basic recorder system (Figure 1-1) consists of a tape transport, head assembly, control unit, electronics assembly, power supply assembly, and input/output module and mainframe assembly.

### 1-2. Tape Transport

All components of the tape transport (Figure 1-2) are mounted on a rigid, precision-machined cast-aluminum base, which also serves as a transistor heat sink for the power supply, tension arm solenoid drivers, and motor drive amplifiers. Mechanical features permit changing from one tape width to the other in less than a minute. The tape transport consists mainly of subassemblies which are easily removed and installed without the need for shims. Electrical connections are made by harness connectors, thereby eliminating the need for soldering.

Basic components of the tape transport are the capstan, supply and takeup motors, supply and takeup constant-tension arms, and tape timer wheel assembly. Tape motion is controlled in all modes of operation (including fast forward,

*Trademark, Ampex Corporation

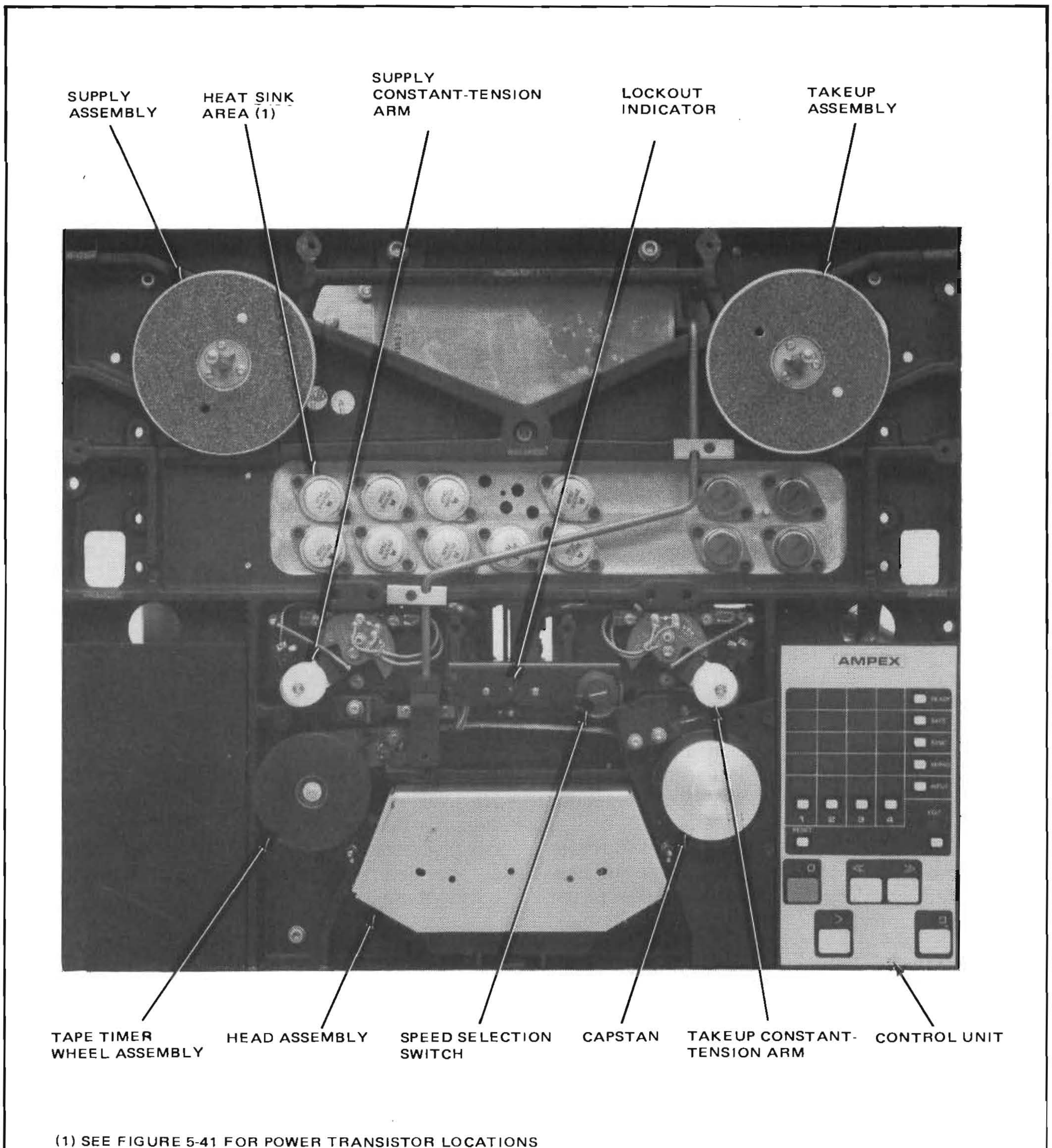



**Figure 1-2. Top View of Tape Transport with Front and Rear Overlay Panels and Head Cover Removed**

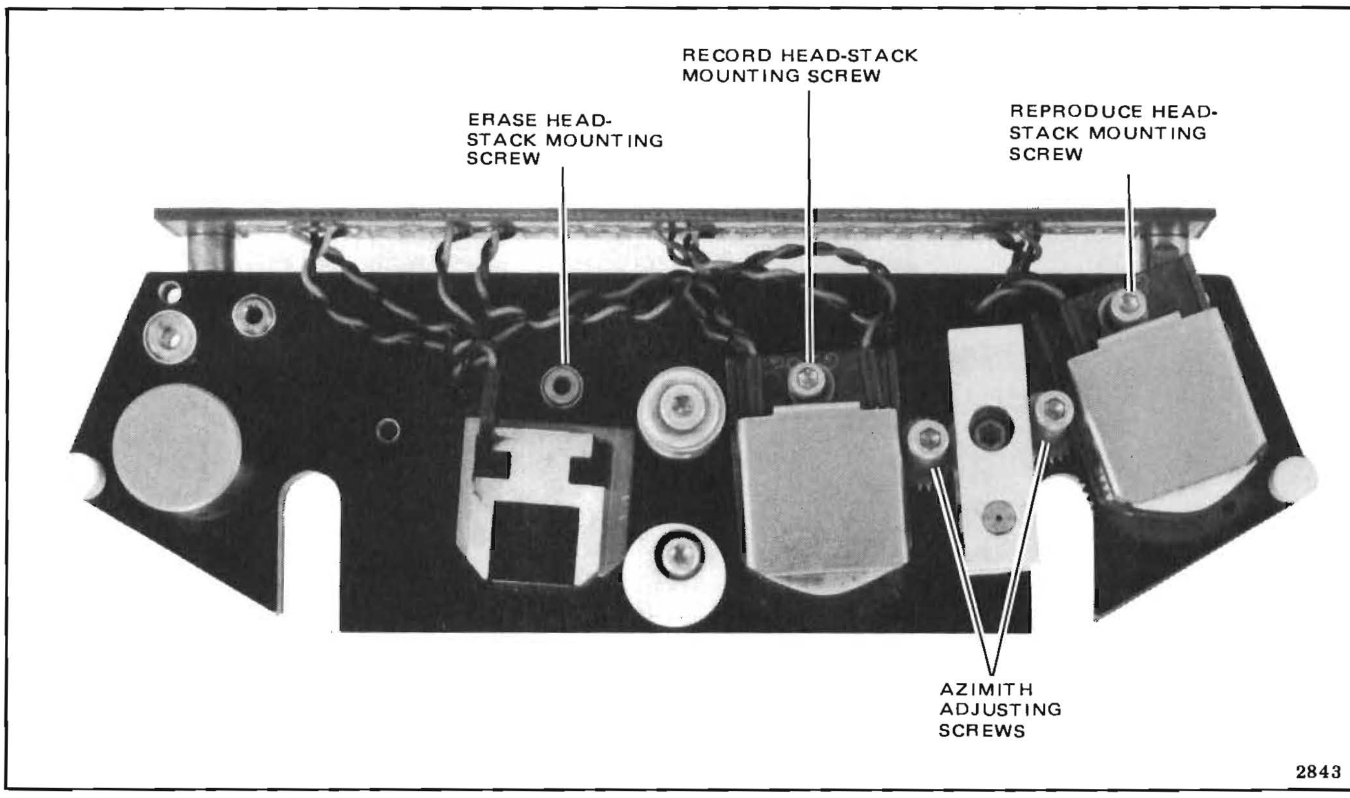



**Figure 1-4. Head Assembly with Head Shield Removed**

stacks are mounted in head mounting positions 2, 3, and 4, respectively, but other combinations are possible. Each head stack is mounted on a precision plate and is easily removed from the head assembly by unplugging the head-stack connector and removing the head-stack mounting screw shown in Figure 1-4.

The only head adjustment required is for record and reproduce head-stack azimuth. This adjustment is made by turning a screw which causes a tapered gear to rotate underneath the head-stack precision plate, thereby providing a limited, but adequate, range of adjustment. (The head design has eliminated the need for adjusting tape wrap, height, and zenith.)

The head stacks are made of composite ferrite-metal, and the record stack has a dual winding so that record and Sel-Sync functions can be separately optimized.

## 1-4. Control Unit

The control unit (Figure 1-5) is capable of controlling up to four audio channels, and enables the operator to initiate all transport and signal mode functions from a single control panel. In addition to controlling all transport functions, such as play, record, fast forward, spool, edit, etc., pushbutton switches associated with each channel enable the operator to program each channel separately for operation in the desired signal mode. This program selection is indicated by light emitting diodes associated with each channel. A tape timer display indicates in hours, minutes, and seconds (or minutes, seconds, and tenths of seconds) the distance the tape has moved from a zero reference point established by pressing a RESET pushbutton switch.

For operator convenience, the control panel may be located either in the left-hand or right-hand position on the transport. An accessory remote control unit with a 25-foot (7.62m) cable is

Table 1-1. Electronics Assembly Printed Wiring Assemblies

| PWA NO. | ASSEMBLY NO. | DESCRIPTION |
|---|---|---|
| 1-4 | 4050754 and 4050755 | Main Audio<br>PADNET (Parameter Determining Network—plugs into Main Audio PWA.) |
| 5 | 4050788 | Audio Control |
| 6 | (Spare) | Can be used to store extender board Assembly No. 4050800 |
| 7 | 4050787 | Transport Control (Transport Logic and Tape Timer) |
| 8 | 4050860 | Capstan Servo |
| 9 | 4050778 | Reel Servo |

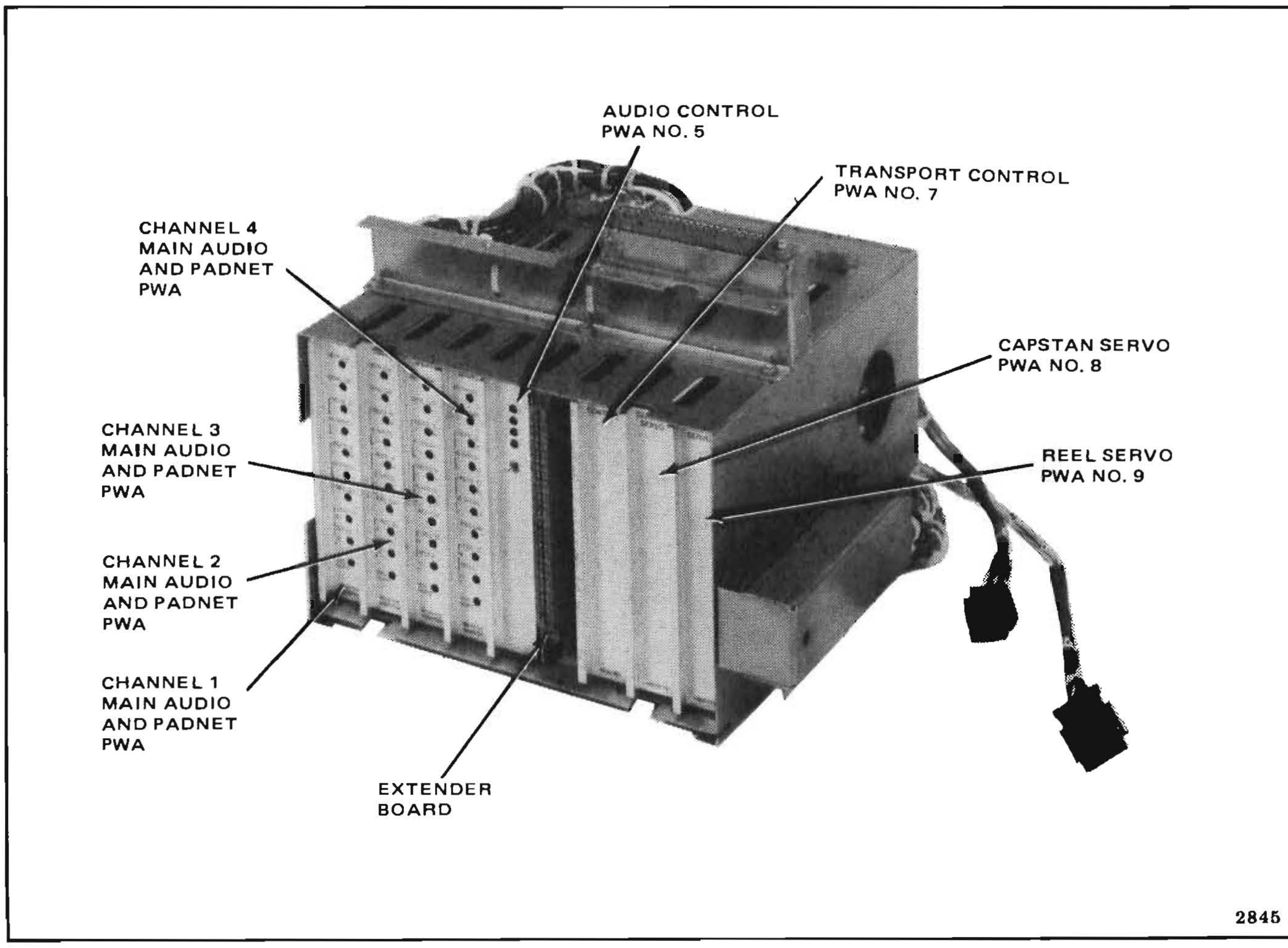



Figure 1-6. Electronics Assembly, Cover Panel Removed

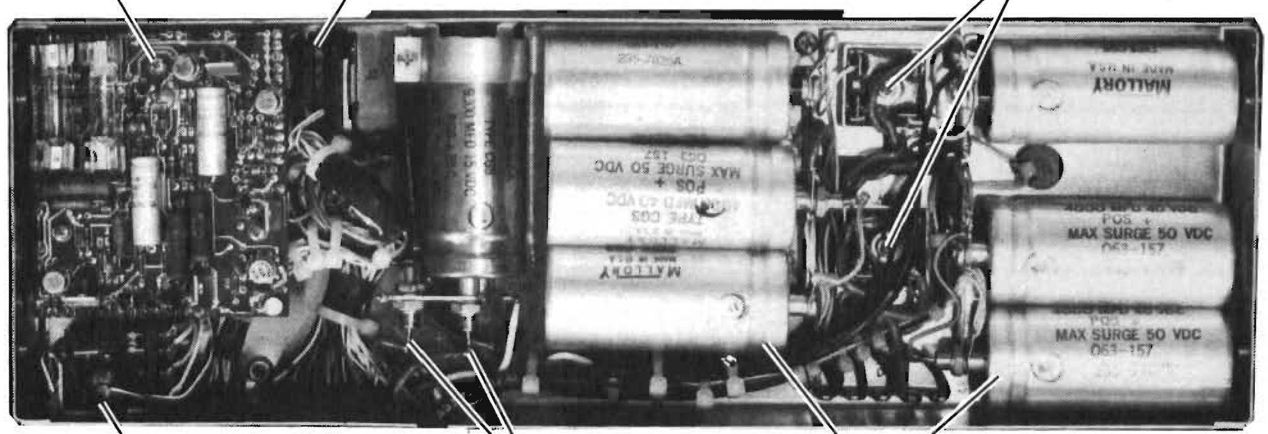



**Figure 1-8. Power Supply Chassis with Cover Panel Removed**

version and may be easily converted from one version to another. Each basic recorder/reproducer is prewired for four-channel operation. For example, to convert from two-channel 1/4-inch tape operation to four-channel 1/2-inch tape operation, only the following, easily installed equipment is required: head assembly, supply and takeup guides, two main audio PWA's, and two PADNET PWA's.

In addition, there are 4 different mounting configurations available: cabinet, cabinet mounted on a roll-around pedestal, fixed-rack mount, and portable case. Four of these configurations are shown in Figure 1-9. Available optional equipment that may be used to convert from one channel configuration or mounting configuration to another is listed in Table 1-2.

## 1-8. Input/Output Module and Mainframe

The input/output module serves as an interface between the input and output of the ATR-100 to permit the operator to adjust and monitor input and output signal levels. These input and output signals can be balanced or unbalanced line. The module includes such features as a switchable peak/vu level meter, input and output line transformers, input and output level controls with preset/manual switch controls, headphone monitoring jack, input amplifier, line output drivers, and bias and erase confidence indicators. One input/output module is used per channel and two input/output modules may be mounted side-by-side in an input/output main frame assembly (Figure 1-10). The main frame assembly may then be installed into an enclosure supplied with the recorder/reproducer cabinet or mounted in a standard 19-inch rack with an optional top cover. Two main frame assemblies may be mounted vertically to accommodate a four-channel system.

## 1-9. ACCESSORIES

Available accessories are listed in Table 1-2.

Table 1-2. Optional Accessory Equipment

| DESCRIPTION | AMPEX PART NO. |
|---|---|
| Line Voltage Warning Card 115 Volts | 4170339-AA |
| Line Voltage Warning Card 230 Volts | 4170339-AB |
| Head Assembly | |
| (1) Full Track, 1/4-inch (6.4 mm) tape | 4020413 |
| (2) Two Track, 1/4-inch (6.4 mm) tape | 4020417 |
| (3) Four Track, 1/2-inch (12.7 mm) tape | 4020418 |
| Tape Guide Assembly | |
| (4) Supply 1/4-inch tape | 4030431-AB |
| (4) Takeup 1/4-inch tape | 4030431-AA |
| (3) Supply 1/2-inch tape | 4030432-AB |
| (3) Takeup 1/2-inch tape | 4030432-AA |
| PADNET 4 Speed | 4050903 |
| (3) Riser Kit (converts cabinet kit assembly from 1 or 2 channel to a 3 or 4 channel version) | 4020429 |
| Pedestal Assembly | 4020426 |
| Edit Kit | |
| 1/4 inch tape | 4010292AA |
| 1/2 inch tape | 4010292AB |
| Cue Amplifier Kit | |
| Console Model | 4010319AA |
| Portable and Rack Mounted Model | 4010319AB |
| CCIR Turntable and Holddown Kit | |
| Including Turntable | 4010299AA |
| Less Turntable | 4010299AB |
| Remote Control Unit, Four-Channel—includes 25-foot (7.62m) captive cable and connector | 4010264 |
| Optional Scrape Flutter Idler (not interchangeable with furnished idler) | 4030402-AB |
| Two-Way Extension Accessory Connector Assembly | 4020432 |

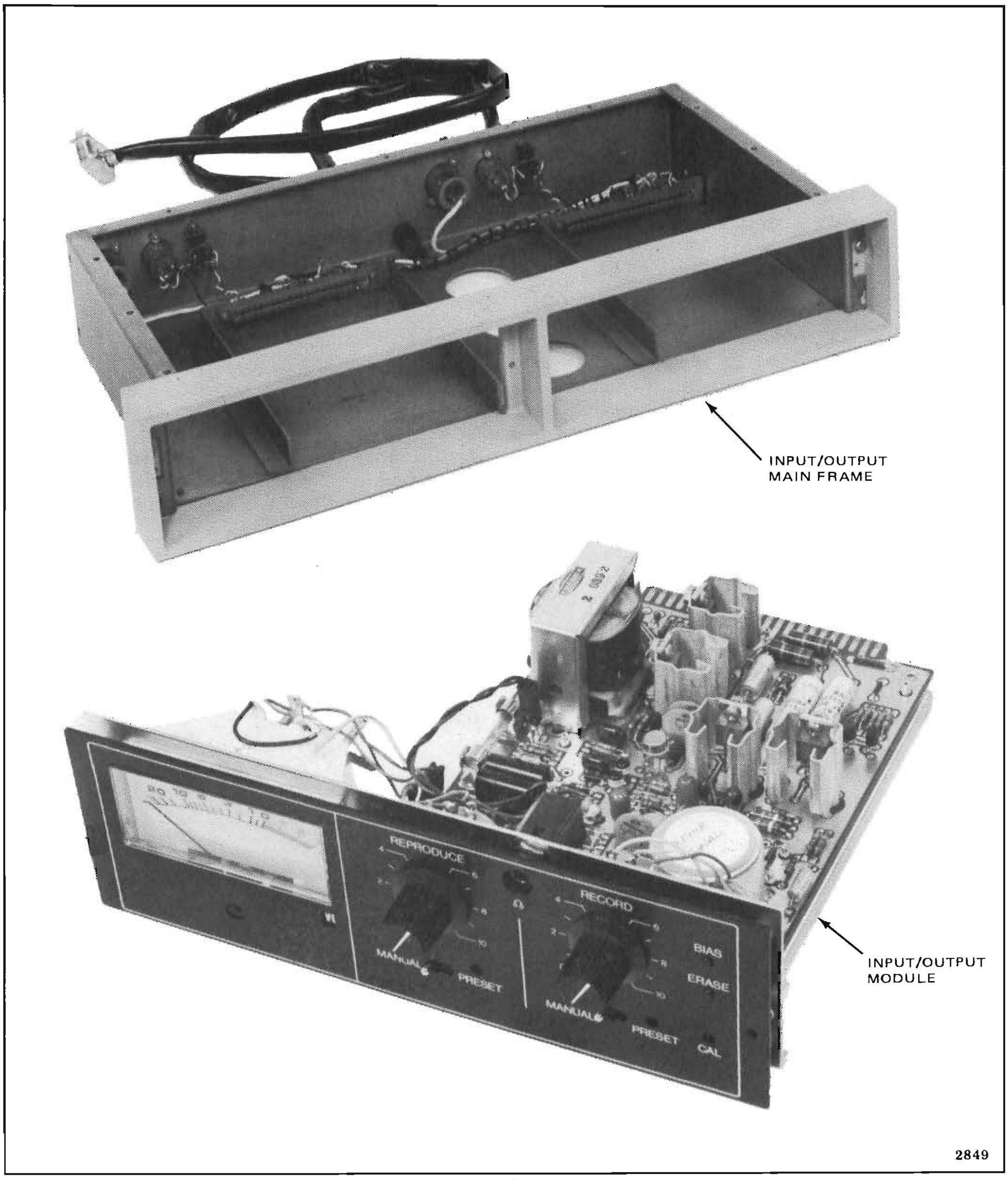



Figure 1-10. Input/Output Assembly

Table 1-3. Specifications (Continued)

**Inputs (with Input/Output System — Bridging Input Standard):**

| | |
|---|---|
| Balanced, floating | |
| Input impedance: | 50 kilohms, resistive ±5.0%, 5 Hz – 20 kHz |
| Input level (variable): | Minimum: -5 dBm, to produce 1,000 nWb/m record flux level<br>Maximum: +40 dBm<br>Input clip level, including record amplifier at mid-frequency: 26 dB above system operating level. |
| Input level (preset): | -1 dBm to +20 dBm to produce 1,000 nWb/m recorded flux level |

**Outputs (with Input/Output System):**

| | |
|---|---|
| Balanced, floating | |
| Output impedance: | <50 ohms, 5 Hz – 20 kHz |
| Maximum output level: | With 600-ohm load: +28 dBm<br>With 200-ohm load; +25 dBm<br>150 ohm load: +23 dBm |
| Preset output level: | Line output level is adjustable over a range of +12 dBm to -2 dBm |
| Metering: | Meters are switchable, vu or peak<br>VU ballistics conform to ASA standards<br>Peak ballistics conform to EBU standards<br>Zero meter reading is continuously adjustable over a range of +12 dBm to -2 dBm line level |

**Inputs (without Input/Output System):**

| | |
|---|---|
| Unbalanced | |
| Input impedance: | 10 kilohms, minimum, 5 Hz – 20 kHz |
| Input level: | -5 dBm, nominal, for system operating level<br>(-5 dBm input level provides 26-dB clip level margin at mid-frequency) |

**Outputs (without Input/Output System):**

| | |
|---|---|
| Unbalanced | |
| Output impedance: | 40 ohms, 5 Hz – 20 kHz |
| Minimum load impedance: | 5 kilohms |
| Output level: | -5 dBm, nominal, for system operating level<br>(-5 dBm output level provides 26-dB clip level margin at mid-frequency) |

**Equalization:**

Any two speeds for the four available are jumper selectable. These two speeds are then automatically switched with transport speed switch. Each speed selected provides equalization adjustable over the range of AES/NAB/IEC/CCIR standards.

Table 1-3. Specifications (Continued)

**System Distortion:**

Electronics Distortion:

System electronics distortion, including record amplifier, reproduce amplifier, and Input/Output system, at any operating level up to 20 dB above operating level at mid-frequency, is <0.03% total harmonic distortion and <0.05% SMPTE intermodulation distortion.

| | |
|---|---|
| Overall record/reproduce distortion (using Ampex 456 tape or direct equivalent): | At system operating level (0 vu = 370 nWb/m; 6 dB above 185 nWb/m) |

Even-Order Distortion:

Even-order distortion of a 1-kHz signal recorded at 370 nWb/m is less than 0.1%.

7.5 in/s - 30 in/s:

| | |
|---|---|
| Third Harmonic Distortion at 1 kHz: | <0.3% at recorded flux level of 370 nWb/m (0 vu)<br><3.0% at recorded flux level of 1040 nWb/m (+9 vu) |
| SMPTE Intermodulation Distortion: | <1.0% at recorded flux level of 370 nWb/m (0 vu) |

3.75 in/s

| | |
|---|---|
| Third Harmonic Distortion at 500 Hz: | <0.5% at recorded flux level of 370 nWb/m (0 vu)<br><3.0% at recorded flux level of 740 nWb/m (+6 vu) |
| SMPTE Intermodulation Distortion: | <2.0% at recorded flux level of 370 nWb/m (0 vu) |

**Crosstalk:**

Crosstalk is measured by simultaneously placing the channel under test, and an adjacent channel in record mode. The adjacent channel is fed with an operating level signal, the channel under test has its input shorted. The residual signal on the reproduced output of the channel under test relative to operating level, is less than 45 dB, 100 Hz – 15 kHz at 15 in/s for 2-track.

**Erase Depth:**

Using Ampex 456 tape or direct equivalent at any wavelength shorter than 75 mils (200 Hz @ 15 in/s) recorded 6 dB above system operating level: 85 dB minimum

**Erase Frequency:** 144 kHz

**Bias Frequency:** 432 kHz

(Both bias and erase frequencies are derived from master crystal oscillator)

**Speed Accuracy:**

(Using 1.0 – 1.5-mil base film thickness tape)

Absolute speed accuracy: ±0.03%

Speed variation from beginning to end of reel: 0.02% maximum

Table 1-3. Specifications (Continued)

| | |
|---|---|
| **Size (Continued):** | |
| Cabinet (1 or 2 channel): | 21 inches (53.34 cm) wide X 19 inches (48.26 cm) high X 32 inches (81.28 cm) deep |
| Cabinet (4 channel): | 21 inches (53.34 cm) wide X 23 inches (58.42 cm) high X 34 inches (86.36 cm) deep |
| Input/Output system (1 or 2 channel): | 19 inches (48.26 cm) wide X 3-1/2 inches (8.89 cm) high X 10 inches (25.4 cm) deep |
| Complete system (including basic machine, 4-channel cabinet, Input/Output system, and roll-around pedestal): | 26 inches (66.04 cm) wide X 46-1/2 inches (118.11 cm) high X 34 inches (86.36 cm) deep |
| **Weight:** | |
| Basic machine: | 125 lbs (56 kg) |
| Cabinet: | 15 lbs (7 kg) |
| Input/Output system (2-channel): | 15 lbs (7 kg) |
| Pedestal: | 50 lbs (23 kg) |
| **Power Line Requirements:** | |
| 90-115, 110-135, 180-230, 220-270 Vac, 50/60 Hz | |
| **Power Consumption:** | |
| 0.6 kVA maximum (with all accessories) | |
| **Environmental Operating Specifications:** | |
| Temperature: | $10^\circ - 50^\circ$C ($50^\circ - 122^\circ$F) |
| Humidity: | 20 – 95%, non-condensing |

# SECTION 2

# INSTALLATION

This section of the manual provides information about unpacking and inspection; choosing the installation site; mounting configurations; equipment connectors and cabling; remote control installation; and initial adjustments including turntable and control unit relocation, spool speed selection, play/edit mode operation lockout, record mode operation lockout, tape timer display selection, and PURC operation selection. Also included is an initial checkout procedure, a discussion of the recorder/reproducer factory-shipped operational configuration, and a procedure for checking operating level.

## 2-1. UNPACKING AND INSPECTION

The ATR-100 series system is shipped in a specially constructed packing case to protect the equipment during transit. When unpacking the unit, use caution to avoid damage to the recorder finish or accessory parts. Remove all material used to secure certain components during shipment. Check the contents of the packing case and packing materials against the packing list to make sure the shipment is complete. Save the packing case and packing materials for shipment of the equipment to another location.

Carefully examine the contents for damage that may have occurred during shipment. Notify the carrier and the local Ampex representative of any shortage or damage.

## 2-2. INSTALLATION SITE

The area chosen for operation of the recorder/reproducer should be adequately ventilated and free of vibration. Surrounding air should be dust free with a temperature range within 50° to 122° Fahrenheit (10° to 50° Centigrade) and humidity within 20 to 95% (non-condensing). The area should not be close to any strong electromagnetic fields. Common sources of interference are fluctuating loads on nearby high current lines, heavy-duty transformers, elevator motors, and radio and television transmitting equipment.

When mounting the equipment, allow sufficient space at the top, bottom, and rear of the unit to permit a flow of cooling air.

## 2-3. MOUNTING THE RECORDER/REPRODUCER

Use these instructions for mounting the recorder in one of the following configurations: console mount, console mounted on a pedestal, fixed rack mount, and slide-rack mount. Mounting dimensions for rack-mount installation are shown in Figure 2-1.

### 2-4. Cabinet Mount

In the cabinet mount configuration, the recorder/reproducer transport and electronics are mounted in a cabinet that can be placed on any firm flat surface. To mount the recorder/reproducer in a cabinet, proceed as follows:

NOTE

**Prior to mounting the recorder/reproducer in a cabinet, perform any desired** *Initial Adjustment* **procedures (paragraph 2-20), and perform the** *Checking Cables and Components* **procedure (paragraph 2-10).**

1. At the top of the transport, remove the rear overlay panel (six screws) shown in Figure 2-2.

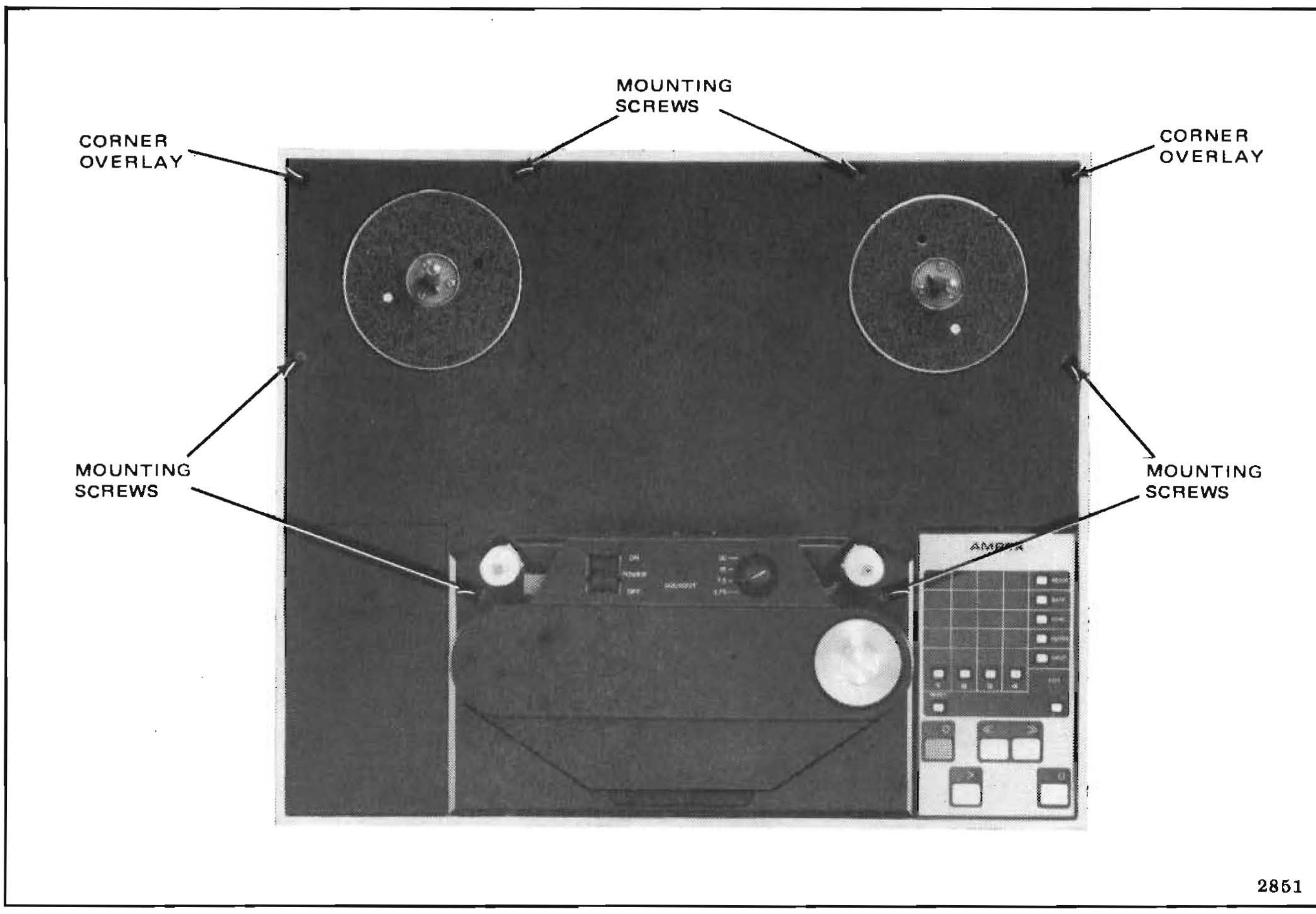



Figure 2-2. Rear Overlay Panel, Six Mounting Screws

2. Locate the three transport mounting holes (0.257 inch in diameter) shown in Figure 2-3.

3. For ease of recorder/reproducer installation, remove the front extrusion assembly (arm rest) from cabinet by removing two screws.

4. Mount the transport into the cabinet using three 10-32 socket head screws provided with the cabinet.

5. Connect cabinet fan connector P20 to power supply connector P20.

6. Reinstall rear overlay panel (six screws).

7. Reinstall arm rest (two screws).

### 2-5. Cabinet Mounted on a Pedestal

In the cabinet mounted on a pedestal configuration, the cabinet is mounted on a pedestal (Figure 2-4) that permits the cabinet to be rotated and placed in any one of five fixed operating positions, or rotated to any desired position for servicing. Proceed as follows:

1. Refer to Figure 2-5 and assemble pedestal as follows:

   a. Fasten each weldment to the panel assembly using three 1/4-20 X 1/2 inch long cap-head hex socket screws, 1/4 split lock washers and 1/4 plain washers. (Place lock washer between screw and flat washer.)

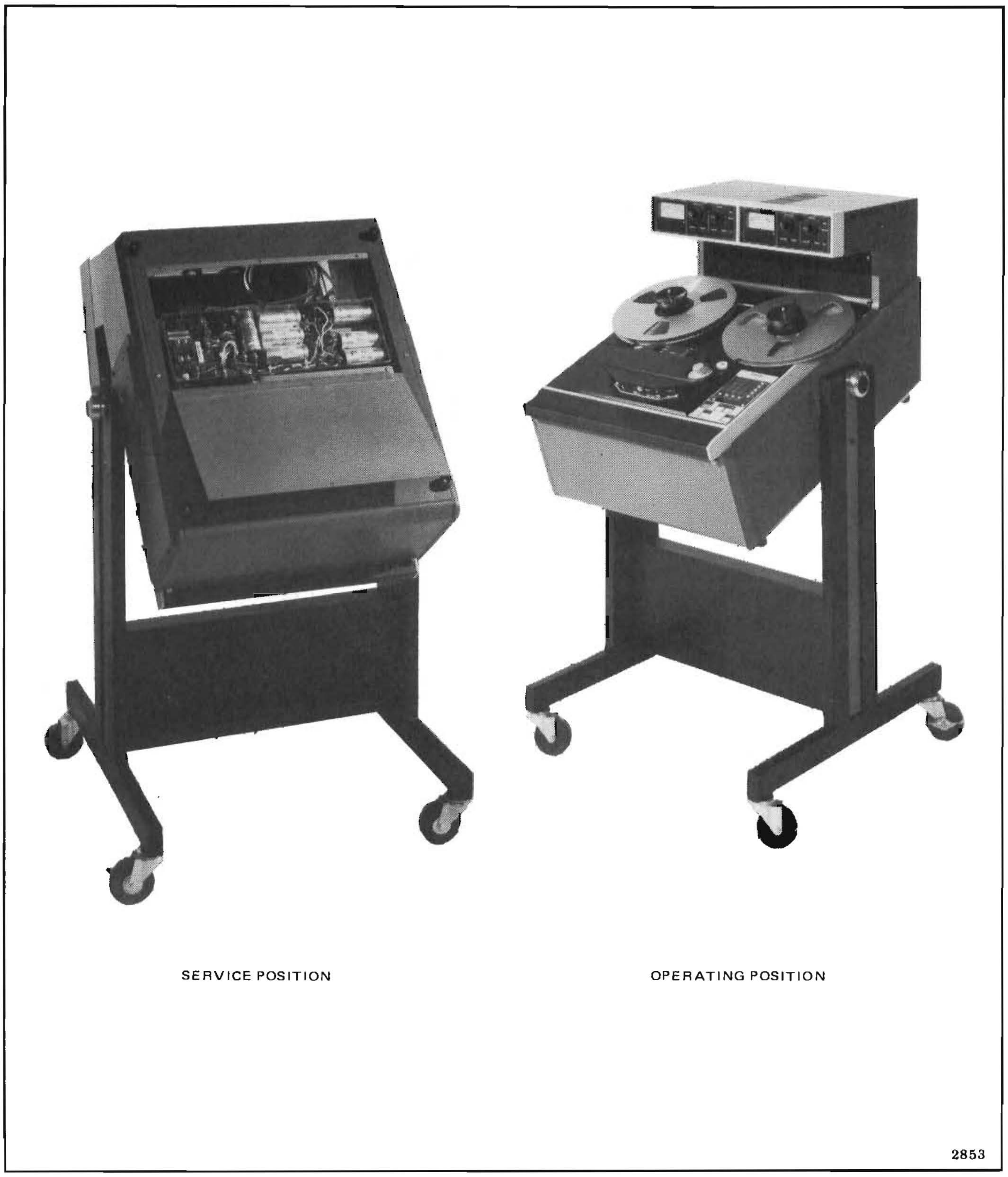



Figure 2-4. Cabinet Mounted on a Pedestal


**Figure 2-6. Fixed-Rack Mount with Electronics Assembly Cover Panel Removed**

6. Install a decorative top cap onto the top of each pedestal weldment. Secure each top cap with two 6-32 X 0.375 button-head hex-socket screws.

## 2-6. Fixed-Rack Mount

In the fixed-rack configuration (Figure 2-6), the electronics assembly chassis is separated from the transport and is mounted directly beneath the transport so that the printed wiring assemblies (PWA's) face forward toward the operator. This equipment is mounted in a standard 19-inch rack or in a custom cabinet as follows:

1. At the top of the transport, remove the rear overlay panel (six screws) shown in Figure 2-2.

2. Locate the three transport mounting holes (Figure 2-3) that are used to mount the transport.

3. Mount the transport onto the rack or custom cabinet using three appropriate size screws, depending on the type of rack or cabinet.

4. Mount the electronics frame furnished in the fixed-rack mount kit directly beneath the transport using four appropriate-size screws, depending on the type of rack or cabinet.

5. Remove the front cover form the electronics assembly and remove all PWA's from the inside of the assembly.

CAUTION

FOR THE FOLLOWING STEPS. DO NOT PUT EXCESSIVE STRAIN ON CABLES OR CONNECTORS. CLIP CABLE TIE DOWNS AS REQUIRED.

6. From the inside of the electronics assembly chassis, remove three 6-32 screws that secure the head cable assembly to the electronics chassis.

7. Carefully unhook electronics assembly chassis from transport and rotate chassis so that interior of chassis faces forward. Slide chassis into flanges of electronics frame.

8. Secure electronics assembly chassis to electronics frame with four 6-32 screws and a lockwasher under screw head.

9. Reinstall PWA's removed in step 5.

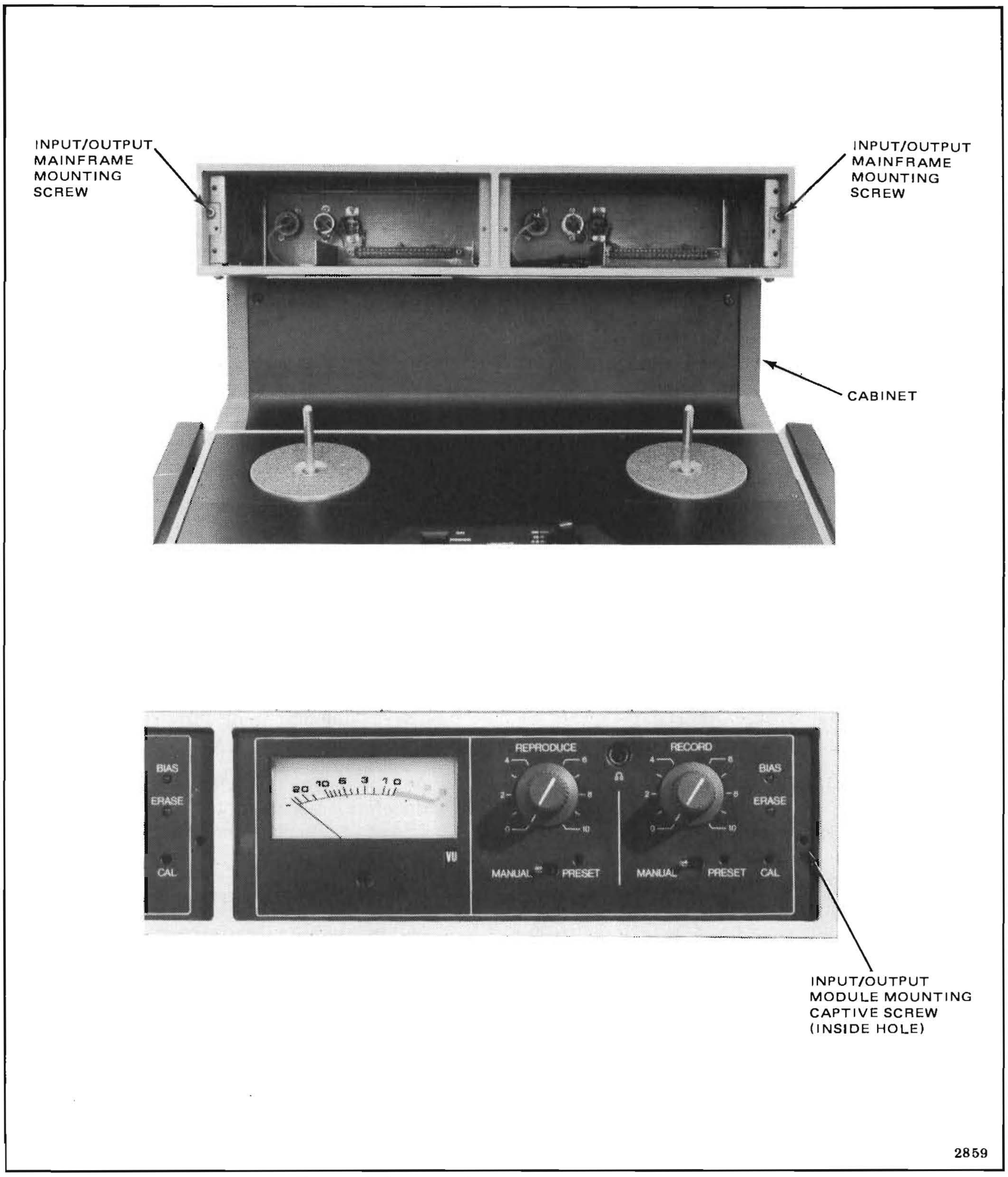



**Figure 2-7. Input/Output Assembly Mounting**

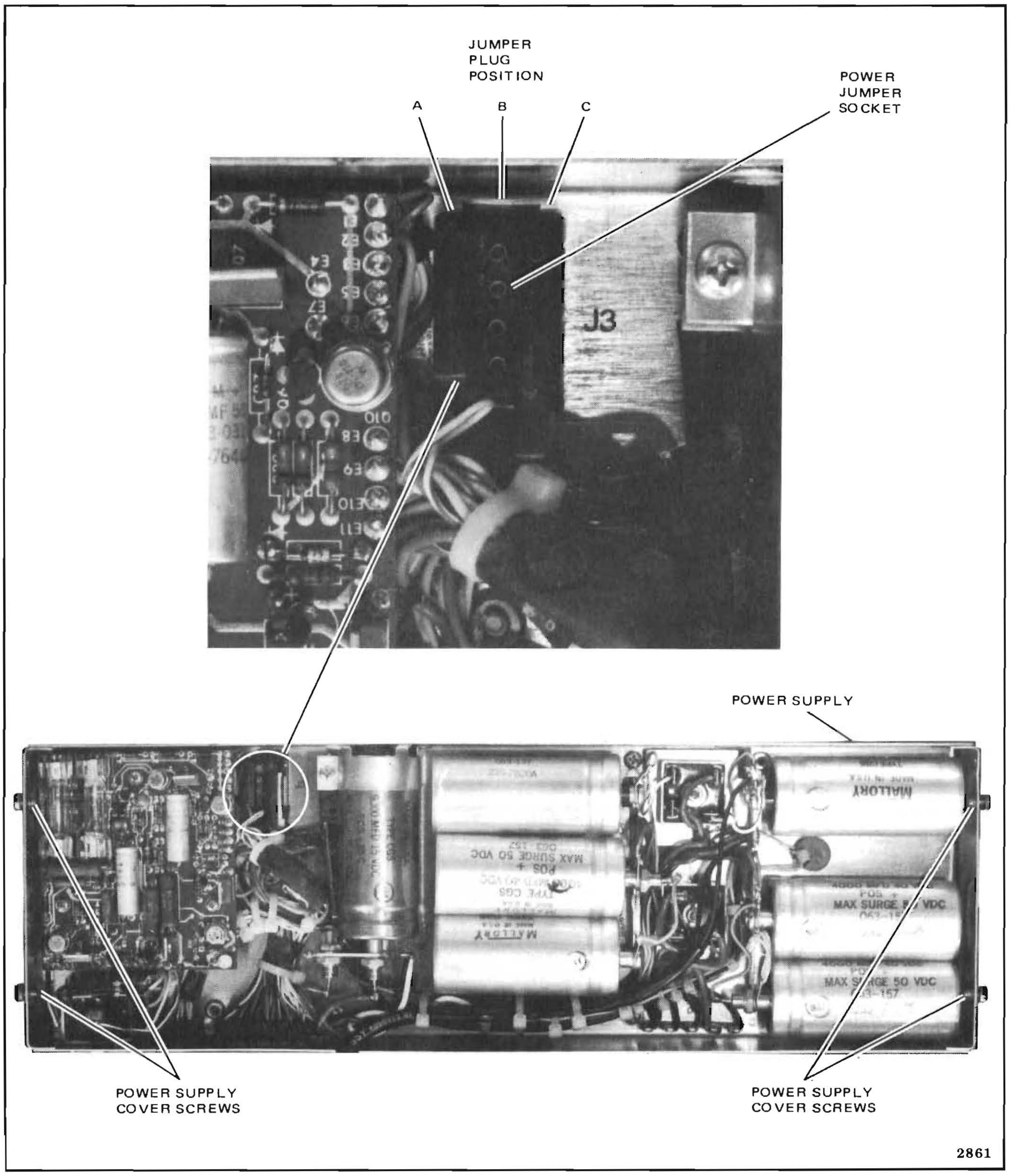



Figure 2-9. Main Power Jumper Location

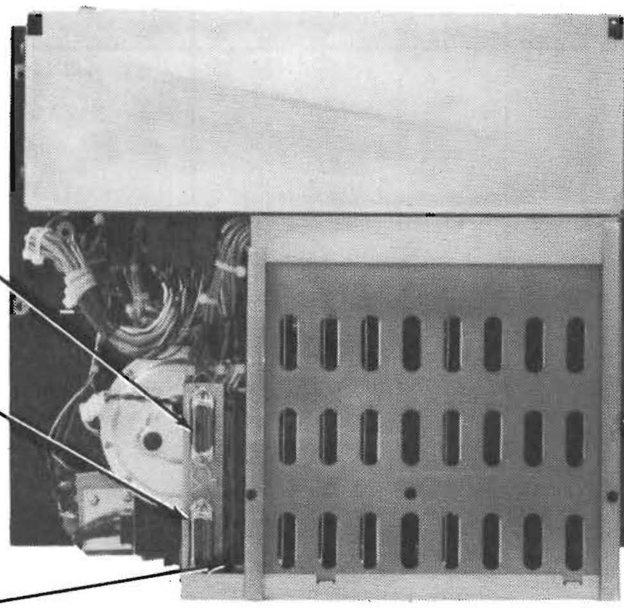



**Figure 2-10. Connector Locations, Bottom View of Recorder/Reproducer**

**Table 2-2. Connector J13 Channel/Signal Identification, Channels 1 and 2**

| J13 CONNECTOR PINS | CHANNEL | SIGNAL |
|---|---|---|
| 1 | 1 | Audio input center conductor |
| 2 | 2 | Audio input center conductor |
| 3 | — | Chassis ground |
| 4 | 1 | Bias voltage status (BVS) |
| 5 | 2 | Bias voltage status (BVS) |
| 6 | 1 | Erase voltage status (EVS) |
| 7 | 2 | Erase voltage status (EVS) |
| 8 | 1 | Unequalized Sel-Sync output |
| 9 | 2 | Unequalized Sel-Sync output |
| 10 | — | Chassis ground |
| 11 | 1 | Audio output center conductor |
| 12 | 2 | Audio output center conductor |
| 13 | 1 | Audio input shield |
| 14 | 2 | Audio input shield |

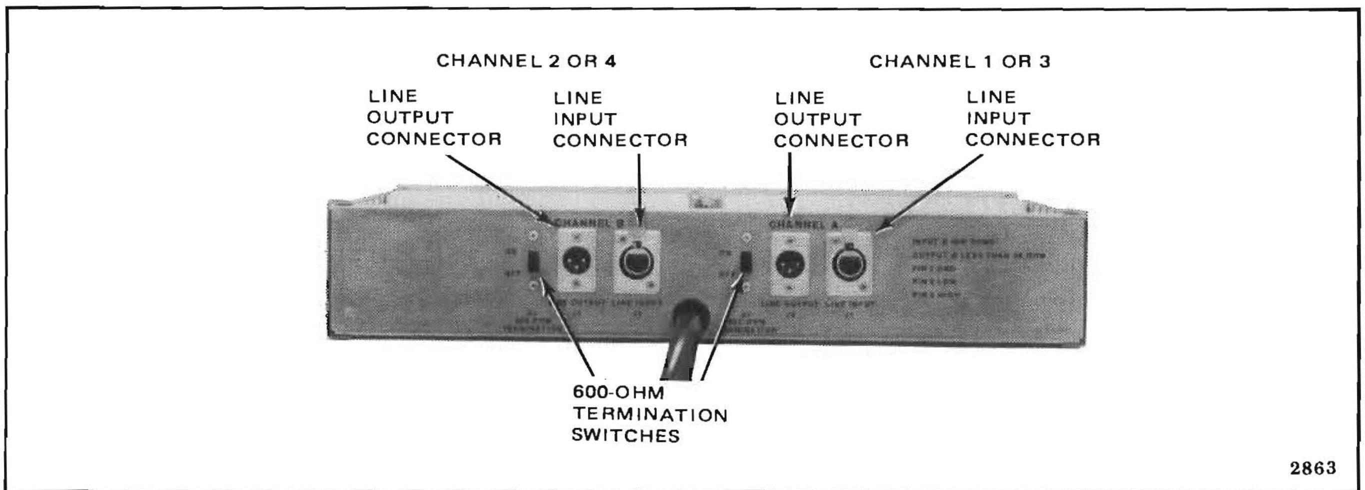



Figure 2-11. Input/Output Assembly, Rear View

## 2-16. Input/Output Assembly Connectors

The audio signal input and output connectors (J1 through J4) on the input/output assembly are located at the rear of the input/output assembly (Figure 2-11). These connectors permit either balanced or unbalanced line inputs and outputs of the recorder/reproducer depending how the connectors are wired. The connectors are standard three-conductor XLR type. Female contact connectors are used for the input signals and male contact connectors are used for output signals. The mating connectors are supplied with the input/output assembly.

The input/output assembly is connected to the recorder/reproducer by means of a captive cable attached to the input/output assembly. Connect this cable to J13 for channels 1 and 2, and to J14 for channels 3 and 4. Connect power return harness from I/O to power supply. To wire the mating plugs, refer to Figure 2-12 and proceed as follows.

**2-17. Input-Connector Wiring.** For balanced inputs, wire male contact XLR connector as follows:

1. Connect signal leads of two-conductor shielded cable to pin 3 (high) and pin 2 (low) of connector.

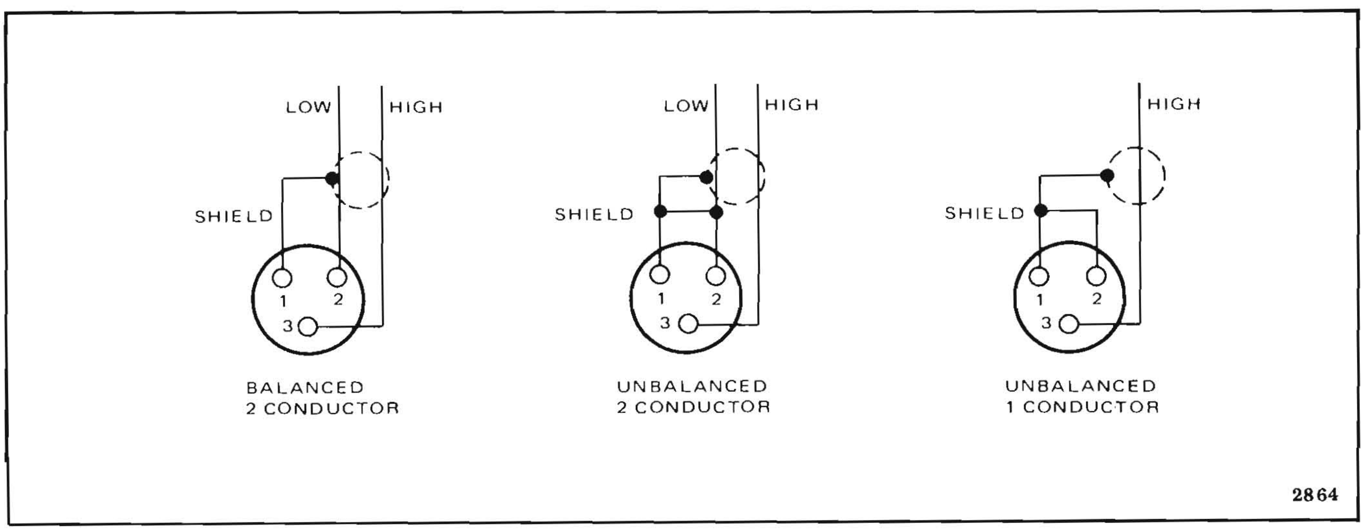
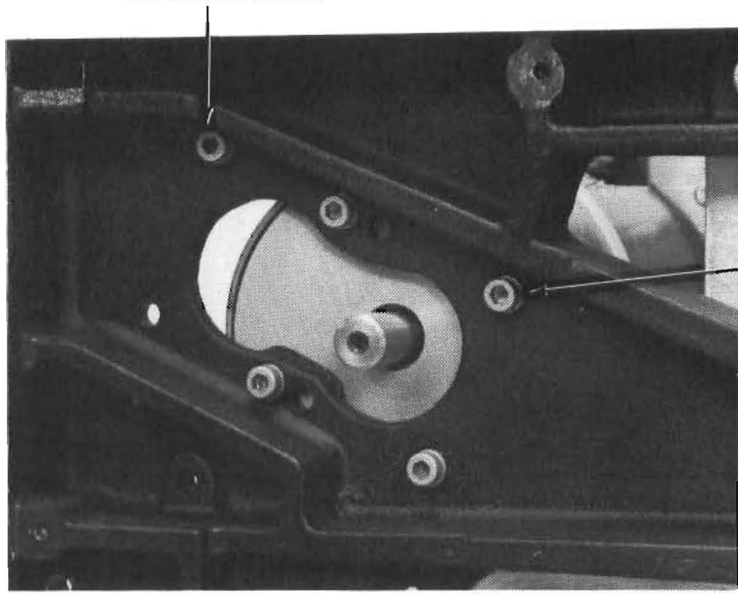
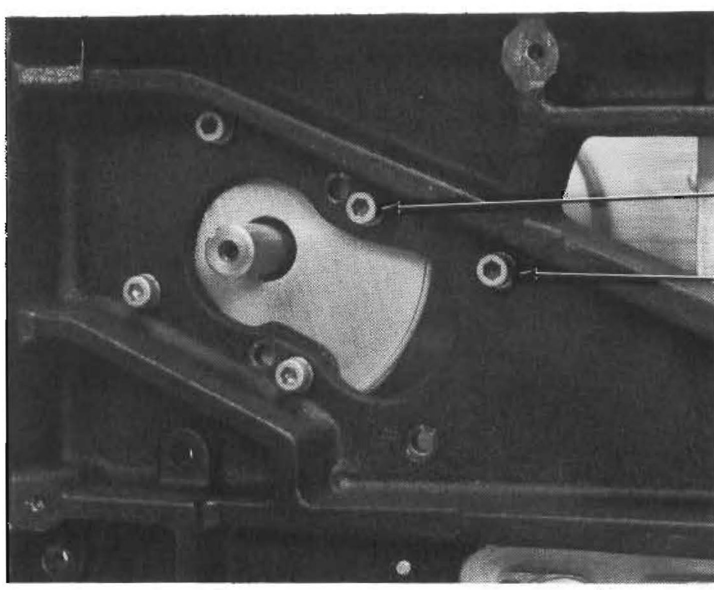



Figure 2-12. Input/Output Assembly Connector Wiring




INNER POSITION




OUTER POSITION

2865

**Figure 2-13. Supply Motor Mounting**

ground strap facing inward ($180^\circ$ from its previous position, shown in Figure 2-15).

7. Reinstall screws removed in step 4 to secure the motor in the outer position as shown in Figure 2-13.

8. Install motor shield ground strap to transport.

9. Tighten power supply screws loosened in step 5.

10. When each turntable is reinstalled on the motor shaft, it is necessary to establish turntable height by setting the turntable clamp approximately 9 mils (0.229 mm) above the surface of the motor.

Proceed as follows:

a. Place a 0.009-inch (9-mil) thick shim or two strips of paper (each approximately the same thickness as this manual page) on the top surface of the end shield plate to serve as a shim.

b. Install the turntable clamp on to the shaft and lower the clamp until contact with the shim is made.

c. Tighten the two clamp hex-head screws.

d. Remove the shim. Turntable must turn freely without rubbing on motor housing.

11. Reverse the position of each corner overlay attached to the rear overlay panel (Figure 2-2) as follows:

a. Remove a single locknut that secures each corner overlay to the rear overlay panel.

b. Rotate the corner overlay $180^\circ$ and re-install locknut.

12. Reinstall rear overlay panel (six screws) to the transport.

## 2-22. Control Unit Relocation

For operator convenience, the control unit (Figure 2-16) may be relocated from the right-hand position on the top of the transport to the left-hand position. To relocate the control unit, it is also necessary to remove the electronics chassis from the transport to gain access to the screws that secure the filler panel shown in Figure 2-17, Proceed as follows:

1. Remove system power.

2. Unplug control unit PCB connector P11 from the electronics assembly double-sided connector J11 (Figure 2-10).

3. From the bottom of the transport, remove four flat-head screws that secure the control unit to the transport casting.

4. Free the control unit from the right side of the transport by carefully feeding the control unit captive cable and connector P11 through the hole in the transport.

5. Remove the electronics assembly from the transport as follows:

a. Remove head cover, head assembly, and the front overlay panel (two screws).

b. Remove ground strap, which connects to electronics assembly, from the tape transport.

c. Disconnect electronics assembly harness connector P16 that connects to tach sensor connector J16.

d. Disconnect electronic assembly harness connector P16 that connects to tach sensor connector J16.

e. Disconnect electronic assembly harness connector P15 that connects to reel drive connector P15.

f. From the bottom of the transport, lift and move the electronics assembly to the left of the transport.

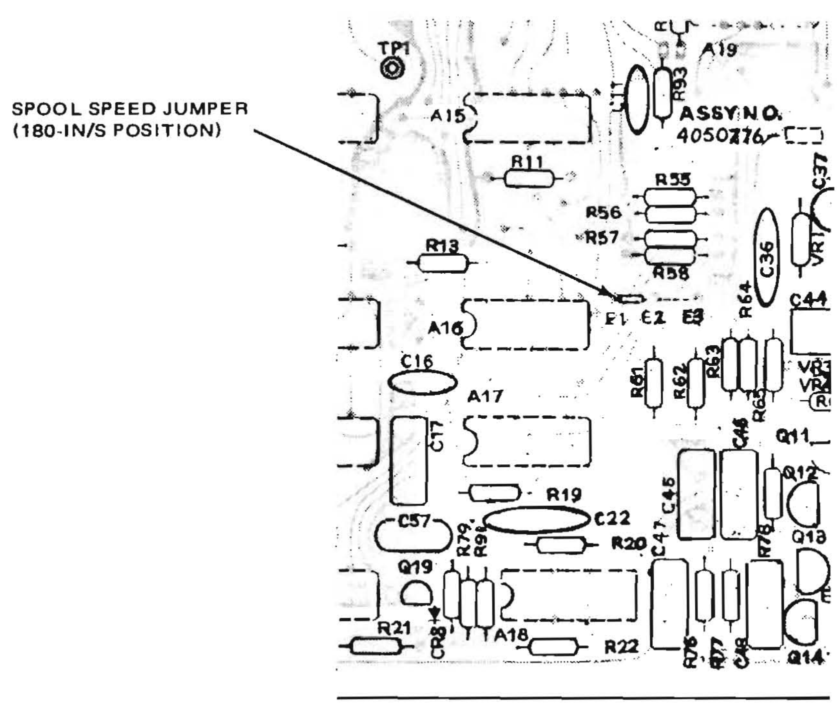



Figure 2-18. Spool Speed Jumper, Capstan Servo PWA No. 8

on the Capstan Servo PWA. (Machines shipped from the factory are set for 180-in/s operation.) To change spool mode speed, refer to Figure 2-18 and proceed as follows:

1. With power off, remove Capstan Servo PWA No. 8 from the electronics assembly.

2. For 60-in/s operation, install jumper between E2 and E3 and solder in place.

3. For 180-in/s operation, install jumper between E1 and E2 and solder in place.

4. Reinstall Capstan Servo PWA No. 8 into electronics assembly.

## 2-24. Play/Edit Mode Lockout

To prevent play/edit mode from being selected from the local control panel, a jumper can be repositioned on Transport Control PWA No. 7. (Machines shipped from the factory are set for play/edit mode operation.) To change jumper position, refer to Figure 2-19 and proceed as follows:

1. With power off, remove Transport Control PWA No. 7 from the electronics assembly.

2. For normal play/edit operation, install jumper between E12 and E13, and solder in place.

3. To prevent play/edit mode from being enabled, install jumper between E13 and E14, and solder in place.

4. Reinstall Transport Control PWA No. 7 into electronics assembly.

## 2-25. Record Mode Lockout

To prevent all channels from entering record mode, a jumper can be repositioned on Audio Control PWA No. 5. (Machines shipped from the factory

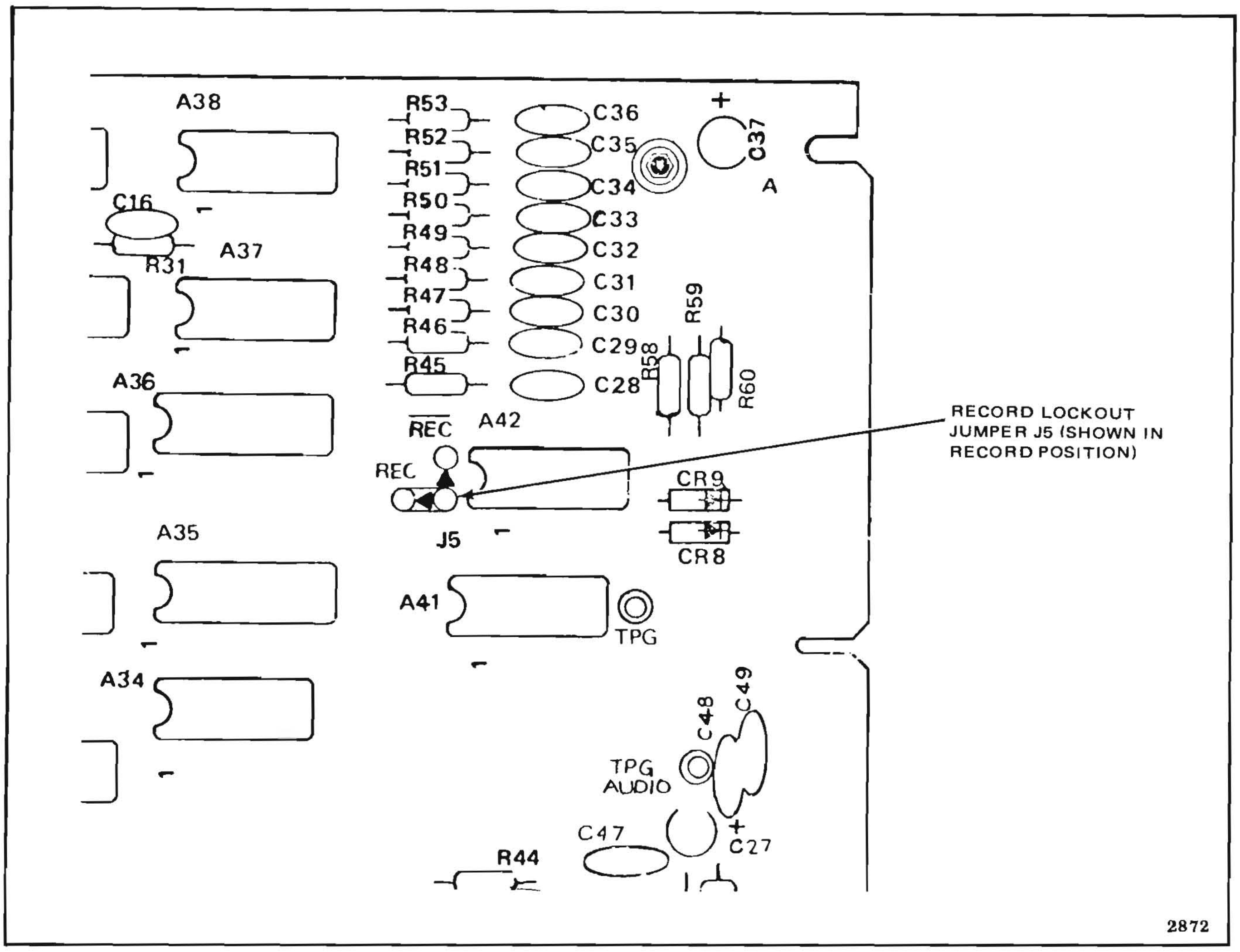



Figure 2-20. Record Lockout Jumper J5, Audio Control PWA No. 5

4. From the rear of the transport casting, remove four flat-head screws that secure the control unit to the casting, to free the control unit.

5. Remove the case bottom of the control unit (Figure 2-22).

6. Remove two screws shown in Figure 2-25 to gain access to six hex spacers shown in Figure 2-23.

7. Remove the four locking plates (Figure 2-23) that prevent the four outer hex spacers from turning.

8. Remove the six hex spacers and remove PWA No. 1 from the control unit housing.

9. Remove jumper on the component side of the board installed between E74 and E76 (Figure 2-24) and install between E74 and E75. Solder in place.

10. Reassemble control unit in the reverse order of disassembly and reinstall into transport.

**2-28. Hours, Minutes, and Seconds Display.** To change display to read hours, minutes, and seconds, proceed as follows:

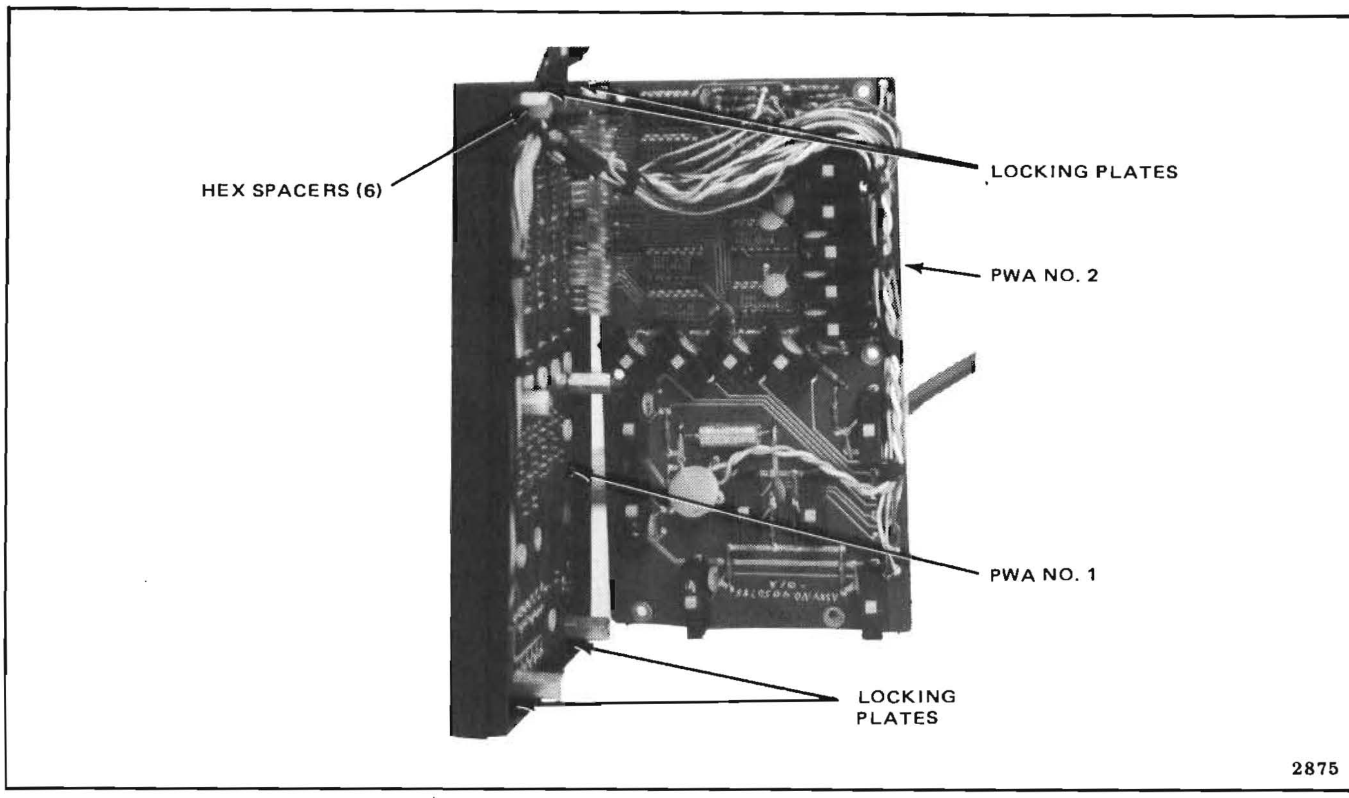



Figure 2-23. Inside View of Control Unit

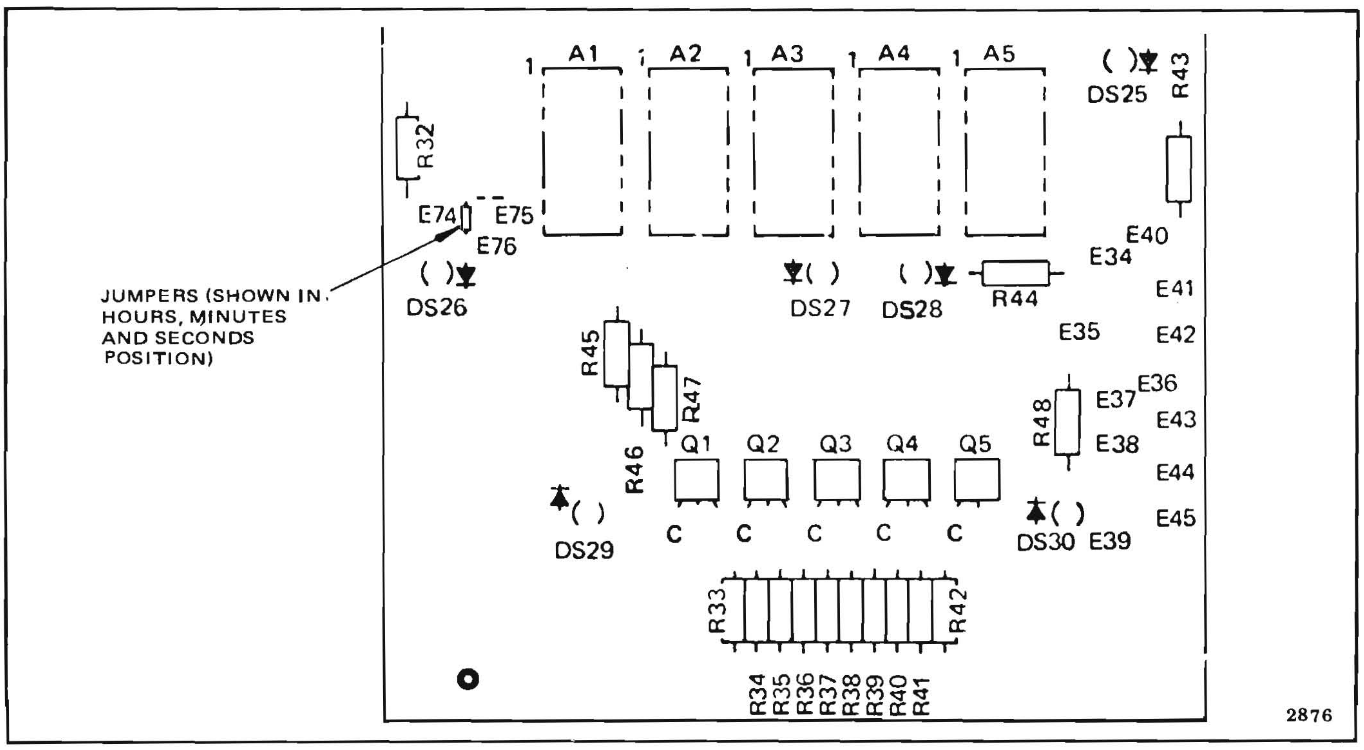



Figure 2-24. Tape Timer Display Selection Jumper, Control Unit PWA No. 1

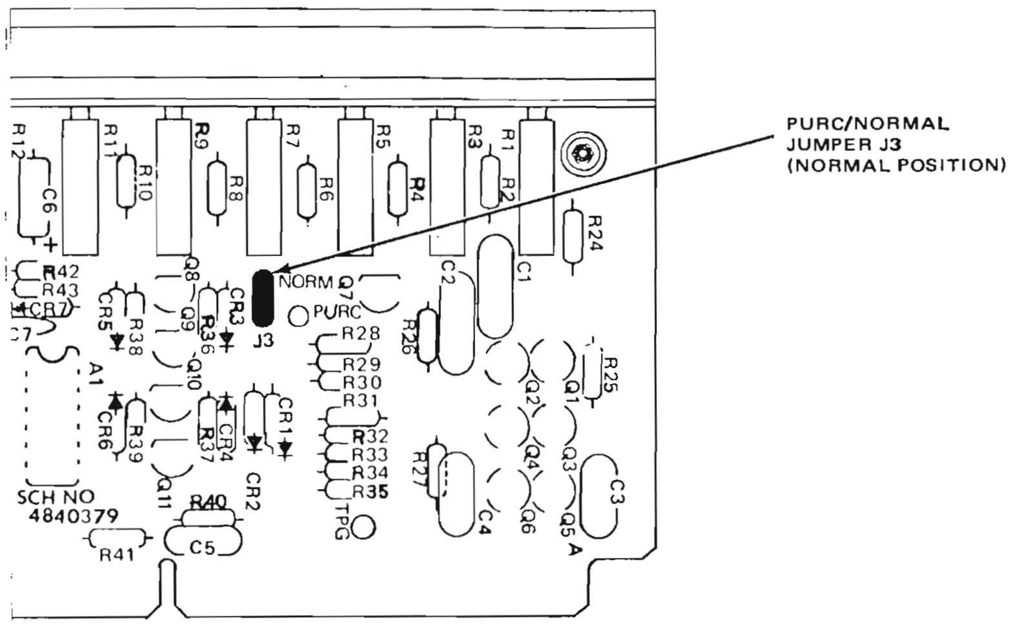



Figure 2-25. PURC Jumper Two-Speed PADNET PWA

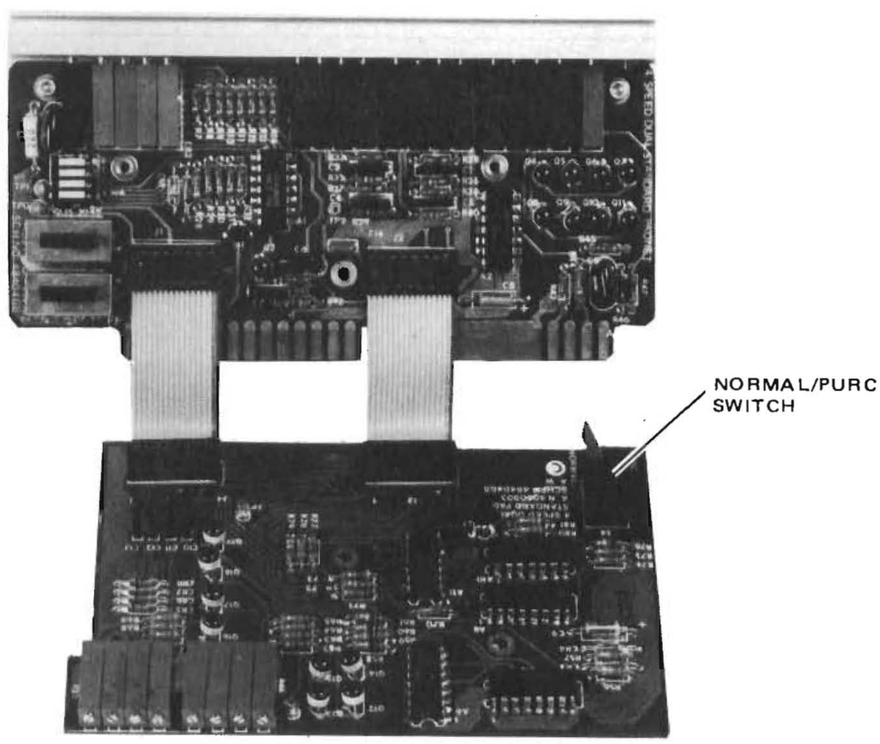



Figure 2-26. NORMAL-PURC Switch Location, 4-Speed PADNET PWA

ready indicator (yellow) should illuminate. Repeat this step for all channels as applicable.

b. Simultaneously press play and record pushbuttons. The ready indicator should go out, the channel record indicator (red) and the master record indicator (red) should illuminate.

c. Press stop pushbutton. The channel record indicator and master record indicator should go out and the ready indicator should illuminate.

d. Simultaneously press a channel select pushbutton and the SAFE pushbutton. The safe indicator should illuminate and the ready indicator should go out. Repeat this step for all channels as applicable.

e. Simultaneously press play and record pushbuttons. The channel record indicator (red) and the master record indicator should not illuminate.

f. Simultaneously press a channel select pushbutton and the SYNC pushbutton. The sync indicator should illuminate. Repeat this step for all channels as applicable.

g. Simultaneously press a channel select pushbutton and the REPRO pushbutton. The repro indicator should illuminate and the SYNC indicator should go out. Repeat this step for all channels as applicable.

h. Simultaneously press a channel select pushbutton and the INPUT pushbutton. The input indicator should illuminate and the repro indicator should go out. Repeat this step for all channels as applicable.

i. While holding channel select pushbutton depressed, press READY pushbutton and then press SYNC pushbutton. The ready and sync indicators should illuminate. Simultaneously press play and record pushbuttons. The following action should take place:

  1) Transport operates at speed selected.

  2) Play and master record indicator illuminates.

  3) Channel ready indicator goes out.

  4) Channel record indicator illuminates.

  5) Sync indicator goes out.

  6) Input indicator illuminates.

j. Press and hold record pushbutton depressed. Momentarily press stop pushbutton. The following action should take place:

  1) Transport operates at speed selected.

  2) Master record indicator goes out.

  3) Channel record indicator goes out.

  4) Channel input indicator goes out.

  5) Channel ready indicator illuminates.

  6) Channel sync indicator illuminates.

k. Press and hold record and stop pushbuttons depressed. Momentarily press play pushbutton. Transport should operate at speed selected. Momentarily again press play pushbutton. Channel should enter and stay in record mode (channel record indicator and master record indicator illuminate) as long as play pushbutton is held depressed. Release pushbuttons and then press stop pushbutton. Transport motion should stop.

l. Repeat steps i, j, and k for all channels as applicable.

## 2-32. FACTORY SHIPPED OPERATIONAL CONFIGURATION

The basic recorder/reproducer is capable of operating at tape speeds of 3.75, 7.5, 15, and 30 in/s

# SECTION 3
# OPERATION

This section of the manual provides locations and functions of the recorder/reproducer operating controls and indicators, a preoperational procedure, and operating instructions for the various modes of operation.

## 3-1. CONTROLS AND INDICATORS

The location and function of each control and indicator are shown in the following tables. Table 3-1 shows those on the tape transport. Table 3-2 lists the transport controls on the recorder control panel. Table 3-3 lists the signal system controls on the recorder control panel, and Table 3-4 lists those on the input/output assembly.

## 3-2. PRE-OPERATING PROCEDURES

See Figure 3-1 and perform the following preoperational procedure.

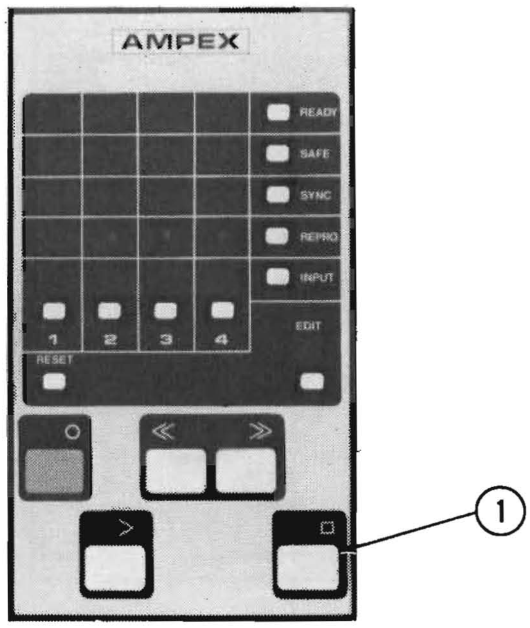
1. Clean and demagnetize components in the tape path as described in the *Maintenance* section of the manual.
2. Set the POWER switch to the ON position. All safe and repro indicators light, and stop and EDIT indicators light and the tape timer indicates zero (0 00 00).
3. Set speed-select rotary switch to desired tape speed; 3.75, 7.5, 15, or 30 in/s. If a speed is selected that the signal system has not been set for, the LOCKOUT indicator lights, play and record modes for that speed are inoperative, and the audio output(s) of the basic recorder/reproducer are muted. If an input/output assembly is connected, the assembly will switch to input signal monitoring.
4. Install reel of tape on supply turntable and empty reel on takeup turntable as shown in Figure 3-1. Reels up to 14 inches (16.54 cm) in diameter and in any size combination may be used. (Note: If reels larger than 11-1/2 inches (29.21 cm) are used, reel motors must be in the "outer" position. Refer to paragraph 2-22.)
5. Lower head shield by pressing shield downward until it locks.
6. Thread tape on transport as shown in Figure 3-1. The tape path is from the supply reel, around the inside of the supply constant-tension arm, around the tape timer wheel, across the head assembly, around the capstan, around the inside of the takeup constant-tension arm, and onto the takeup reel.
7. Turn one reel to remove all tape slack.

**CAUTION**

**DO NOT TOUCH THE CONSTANT-TENSION ARMS WHEN RECORDER/REPRODUCER IS IN THE ELECTRICAL THREAD CONDITION. TO DO SO WILL INTRODUCE A REEL SERVO ERROR AND POSSIBLY CAUSE TAPE DAMAGE.**

8. While holding the stop pushbutton pressed, turn either reel to slacken tape and then tighten tape with a short quick movement to apply tension to the constant-tension arms. This action causes the reel servos to activate and recorder/reproducer enters electrical thread mode. The electrical thread mode is indicated by the EDIT indicator light going out. (To deactivate the thread mode, press EDIT pushbutton when tape is stopped. Reel servos will disengage and tape may be removed from transport if desired.)

Table 3-2. Recorder Control Panel, Transport Controls and Indicators

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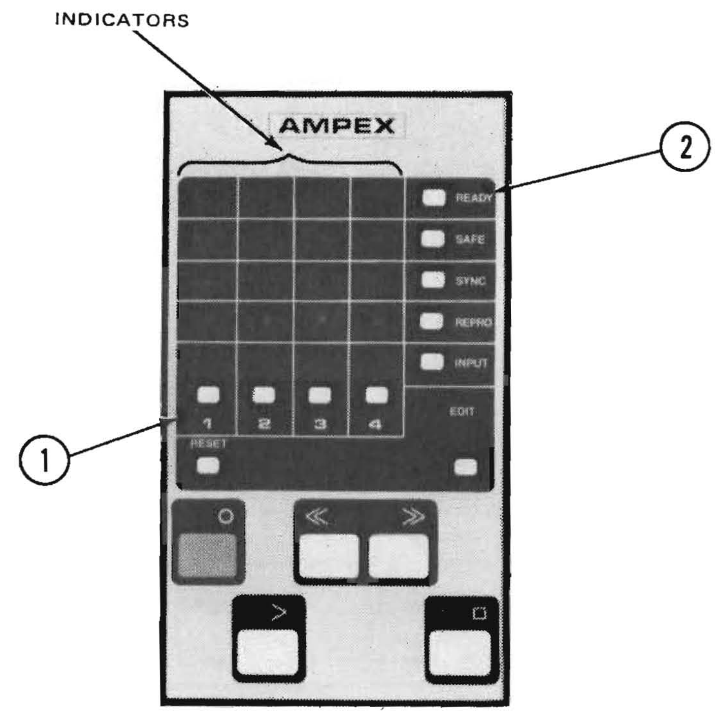
| INDEX NO. | NAME | FUNCTION |
|---|---|---|
| 1 | ☐ Stop pushbutton switch | Used to initiate the following functions:<br><br>*Thread.* After tape is manually threaded on the transport and tape slack removed, either reel is quickly turned by hand to apply tension to the tension arms while the stop pushbutton is simultaneously pressed. This causes reel servos to activate and place transport in a thread condition. Thread condition is indicated by EDIT indicator light (index no. 11, this table) going out.<br><br>*Stop.* Switch stops tape transport motion and cancels existing mode of operation. Note: When any channel is in record mode, tape motion does not stop until record signal has decayed.<br><br>*Stop Record.* Also used to stop recording without stopping transport if record pushbutton (index no. 5) is held pressed while stop pushbutton is momentarily pressed.<br><br>*Momentary Record.* Also used in conjunction with play and record pushbuttons (index no. 3 and 5, this table). If stop and record pushbuttons are held pressed, record mode is entered when play pushbutton is pressed and held. Record mode stops when play pushbutton is released, but transport motion continues. |

**Table 3-2. Recorder Control Panel, Transport Controls and Indicators (Continued)**

| INDEX NO. | NAME | FUNCTION |
|---|---|---|
| 5 | Record pushbutton switch | Used in conjunction with play pushbutton (index no. 4). Simultaneously pressing play pushbutton and record pushbutton initiates record mode of channel(s) in ready mode.<br><br>Also used to select momentary record mode (see index no. 1, this table). |
| 6 | Master Record indicator (red) | Lights when any channel is recording |
| 7 | Rewind pushbutton switch | Used to select rewind mode. Also used to select spool mode in the rewind direction when the play pushbutton (index no. 3) and the rewind pushbutton are pressed simultaneously. |
| 8 | Rewind indicator (yellow) | Lights when rewind or rewind spool mode is selected. |
| 9 | Fast Forward indicator (yellow) | Lights when fast forward or forward spool mode is selected. |
| 10 | Fast Forward pushbutton switch | Used to select fast forward mode. Also used to select spool mode in the forward direction when the play pushbutton (index no. 3) and the fast forward pushbutton are pressed simultaneously. |
| 11 | EDIT indicator (yellow) | Lights when power is first applied to recorder. Light goes out when stop pushbutton is pressed and thread condition is obtained (refer to index no. 1). Indicator also lights in edit modes of operation. |
| 12 | EDIT pushbutton switch | If tape motion is stopped, pressing EDIT causes recorder to go into unthread condition (reel servos disengage) and tape may be removed from transport if desired.<br><br>Also used to initiate one of the following edit modes:<br><br>*Stop/Edit:* If tape is stopped, pressing EDIT disengages reel servos for tape threading, editing, or manual tape movement.<br><br>*Play/Edit:* If play or record mode is active, pressing EDIT pushbutton causes the following action: Tape motion continues in play mode; power is removed from takeup reel; and takeup tension-arm roller engages capstan causing tape to be spilled at takeup side of transport.<br><br>If in Play/Edit mode and stop pushbutton is pressed, tape will stop, edit mode will be retained, and tape can again be spilled by pressing play pushbutton. To cancel play/edit mode, press stop pushbutton and after tape stops, press EDIT. |

**Table 3-3. Recorder Control Panel, Signal System Controls and Indicators**




| INDEX NO. | NAME | FUNCTION |
|---|---|---|
| 1 | Channel Select pushbutton switches (4) | Switches permit channel (1, 2, 3, 4) selection for various modes of operation. Used in conjunction with the READY, SAFE, SYNC, REPRO, and INPUT pushbutton switches (index no. 2 – 6). |
| 2. | READY push-button switch and Ready (yellow) and Record (red) Channel 1 – 4 indicators | Used in conjunction with channel select pushbutton switch (index no. 1 of this table). In ready, channel is enabled for entering record mode.<br><br>Ready indicator(s) light when READY pushbutton switch and corresponding channel select pushbutton switch (index no. 1, this table) are simultaneously pressed. Record mode is entered by simultaneously pressing play and record pushbutton switches (index no. 3 and 5, Table 3-2). When record mode is entered, ready (yellow) indicator goes out and record (red) indicator lights, indicating the channel(s) in record mode.<br><br>If channel is in record mode and READY pushbutton and same channel select pushbutton switch are simultaneously pressed, the channel will go out of record and will return to ready mode. Record mode may be reentered by simultaneously pressing play and record pushbutton switches (index no. 3 and 5, Table 3-2). Tape motion and status of other channels are not affected by this action. |

Table 3-3. Recorder Control Panel, Signal System Controls and Indicators (Continued)

| INDEX NO. | NAME | FUNCTION |
|---|---|---|
| 4 (Continued) | | If in Sel-Sync and ready modes the record mode is entered, input signal being recorded is connected to audio output of that channel. Sync indicator light goes out and input indicator lights. If channel is removed from record mode, system returns to sync mode and sync indicator lights (unless repro or input monitoring were selected while in record mode). |
| 5 | REPRO pushbutton switch and Repro Monitoring Channel 1 – 4 indicators (yellow) | Used in conjunction with channel select pushbutton switch (index no. no. 1). In repro, signal being reproduced by reproduce head is connected to audio output.<br><br>Repro indicator(s) light when power is initially applied or when REPRO pushbutton and corresponding channel select pushbutton switch (index no. 1) are simultaneously pressed. When lit, signal being reproduced by reproduce head is connected to audio output. |
| 6 | INPUT pushbutton switch and Input Monitoring Channel 1 – 4 indicators (yellow) | Used in conjunction with channel select pushbutton switch (index no. 1). Input signal to recorder is connected to audio output.<br><br>Indicator(s) light when INPUT pushbutton and corresponding channel select pushbutton switch are simultaneously pressed. When lit, input signal to recorder is connected to audio output connector for monitoring purposes (E-E mode).<br><br>Indicator also lights if record mode is entered while in sync mode. |

Table 3-4. Input/Output Module, Controls and Indicators (Continued)

| INDEX NO. | NAME | FUNCTION |
|---|---|---|
| 6 | Phone jack | Receptacle for headphone plug. Audio of associated channel can be monitored on headphones (600 ohms or greater impedance). |
| 7 | RECORD level control | Control used, when MANUAL/PRESET toggle switch (index no. 12) is in MANUAL position, to vary record level of associated channel. |
| 8 | BIAS indicator | Indicator lights in record mode to indicate that bias signal is present at the record head. |
| 9 | ERASE indicator | Indicator lights in record mode to indicate that erase signal is present at the erase head. |
| 10 | Record PRESET adjustment control (R2) | Used to preset record input level. |
| 11 | Record CAL adjustment control (R3) | Used to set input monitoring level and meter indication to match reproduced level from tape. |
| 12 | Record MANUAL/ PRESET toggle switch | Switch used to select MANUAL or PRESET record level. In MANUAL position, RECORD level control (index no. 7) is used to vary record level of associated channel. In PRESET position, record level is controlled by the setting of the record PRESET adjustment control (index no. 10). |

4. Simultaneously press the channel select pushbutton switch and the INPUT pushbutton switch for each channel selected for record mode.

5. Connect signal(s) to be recorded to the appropriate audio input connectors.

6. If system is equipped with an input/output module assembly, perform one of the following steps for each channel to be recorded.

   a. Set RECORD MANUAL/PRESET switch to PRESET and observe level meter for desired indication. If level is not correct, adjust level fed to input/output assembly or perform step b.

   b. Set RECORD MANUAL/PRESET switch to MANUAL and adjust RECORD level control for desired indication on meter.

7. Simultaneously press play and record pushbutton switches to start tape motion and begin recording on selected channel(s). (An alternate method is to depress play pushbutton to start tape motion and then, while holding play pushbutton depressed, press record pushbutton.) The master record indicator (red) and the channel record indicator(s) will light.

8. If desired while recording, the input signal for each channel can be compared with the recorded signal on that channel by holding the channel selector pushbutton depressed and alternately pressing the associated INPUT and REPRO pushbutton switches.

9. When recording is complete, record mode may be terminated by performing any one of the following steps. (Note that internal logic control circuitry will delay any commanded change in tape motion direction or velocity until after all channels have completely terminated record mode.)

   a. Press stop pushbutton to stop tape motion and deactivate record mode.

   b. Depress record pushbutton and momentarily press stop pushbutton. Record mode will be terminated but transport will continue to run at the selected tape speed.

   c. Press rewind or fast forward pushbutton.

   d. Simultaneously press a channel select pushbutton and a SAFE or READY pushbutton to deactivate record on any individual channel as transport continues to run at the selected tape speed.

## 3-5. Fast Winding

For fast-winding operations (fast forward or rewind modes), press either the rewind or fast forward pushbutton switch. The associated rewind or fast forward indicator (yellow) will illuminate. For editing or cueing operations, these pushbuttons can be pressed alternately without having to press the stop pushbutton between fast-winding selections. Either fast winding mode can be entered from stop, play, or record mode.

Play mode may be entered while in fast forward or rewind mode by pressing the play pushbutton switch. Record mode may only be entered from play mode, provided that capstan servo lock is obtained within 0.8 second.

Two tape lifter arms that move the tape away from the heads are automatically actuated in both fast-winding and spool modes. To monitor audio in either of these modes, press the EDIT pushbutton switch. The tape lifters will retract while the pushbutton is held pressed.

## 3-6. Reproducing

Proceed as follows:

1. Perform all steps of the pre-operating procedures.

2. Simultaneously press the channel select pushbutton switch and the SAFE pushbutton switch for each channel. The associated safe indicator (green) will illuminate. (Note: When the recorder is initially turned on, all channels will automatically be in safe and repro modes.)

1. Thread Mode. If tape is stopped in thread mode, the capstan edit knob may be turned in either direction to move tape from reel to reel under reel-servo control.

2. Stop/Edit Mode. If tape is stopped in thread mode, pressing the EDIT pushbutton switch causes recorder to enter unthread mode (reel servos disengage) and reels are free to turn for editing, splicing, or manual tape movement. (Note: This function is disabled when operating recorder from a remote control unit.)

3. Play/Edit Mode. If play or record mode is active, pressing EDIT pushbutton switch causes tape motion to continue in play or record mode, removes power to takeup reel, and causes takeup tension-arm roller to engage capstan which causes tape to be spilled at takeup side of transport. (Note: This function is disabled when operating recorder from a remote control unit.)

   If in play/edit mode and stop pushbutton switch is pressed, tape will stop, edit mode will be retained, and tape can again be spilled by pressing play pushbutton switch. To cancel play/edit mode, press stop pushbutton and after tape stops, press EDIT pushbutton. To enter record mode from play/edit mode, press play and record pushbutton switches simultaneously.

4. Shuttle/Edit or Spool/Edit Mode. If EDIT pushbutton is pressed while in fast forward, rewind, or spool mode, the tape lifters retract allowing recorded material on tape to be reproduced as long as EDIT pushbutton is held pressed.

### 3-10. Spooling

Spool mode is used to transfer tape from reel to reel at a constant speed (60 in/s or 180 in/s) to obtain a uniform tape pack. (Refer to paragraph 2-24 for procedure to select spool speed.)

1. To select forward spool mode, simultaneously press the play and the fast forward pushbutton switch. The fast forward indicator (yellow) will illuminate and the play indicator (green) will illuminate when spool speed is obtained.

2. To select rewind spool mode, simultaneously press the play and rewind pushbutton switch. The rewind indicator (yellow) will illuminate and the play indicator (green) will illuminate when spool speed is obtained.

3. If in either forward or rewind spool mode and it is desired to reverse spool mode direction, only the opposite direction pushbutton switch (fast forward or rewind) need be pressed.

4. To deactivate spool mode, press stop pushbutton switch. Another mode of operation, except record, may then be selected before tape comes to a stop.

### 3-11. Remote Control Operation

All recorder functions may be controlled from the remote control unit with the exception of initiating play/edit or stop/edit (unthread) modes. Except for these two functions, the remote control unit operates in parallel with the local control unit at all times.

### 3-12. PURC Operation

The recorder/reproducer is capable of operating with or without PURC (pick-up recording capability) operation as desired, by placement of a jumper located on the 2-speed PADNET PWA or a switch on the 4-speed PADNET PWA. (Refer to paragraph 2-30.) Recorders shipped from the factory are set for normal (non-PURC) operation.

The use of PURC eliminates the problem of overlaps and holes in recordings when inserting (dubbing) new material within previously recorded programs. In a recorder system without PURC, initiating record mode energizes the erase and record heads simultaneously. Since there is a physical distance between the erase and record head, a period of over-recording on unerased tape occurs. When the dub is terminated, a hole is left in the program. The length of time of this hole is related to the distance between the erase and record head and the speed of the tape.

If an insert edit is to be made on one or two tracks of a four-track recording, monitor one or two tracks of the tracks in Sel-Sync mode. This will aid in synchronizing the new recording with the tracks being monitored.

The on and off delay times shown in Table 3-5 can be used to anticipate when the start and stop recording times are to take place. If one of the tracks is recorded with a timing signal, such as the SMPTE time-and-control code signal, precise editing can be obtained.

**3-14. Insert Edit.** A suggested method of performing an insert edit is as follows:

1. For channel(s) to be edited, simultaneously press the channel select pushbutton switch and the READY pushbutton switch.

2. For channel(s) not to be edited, simultaneously press the channel select pushbutton switch and the SAFE pushbutton switch.

3. Rewind the tape to a point before the point to be edited.

4. Press play pushbutton switch to place system in play mode.

5. Press and hold record pushbutton switch, and then press and hold stop pushbutton switch.

6. While still holding the record and stop pushbutton switches depressed, press play pushbutton switch just prior to the edit point (Table 3-5) to start record mode.

7. Continue holding all three pushbutton switches depressed and, just prior to the end of the edit point (Table 3-5), release play pushbutton switch to stop record mode. Transport will continue to run in play mode. Release other pushbuttons and enter any mode desired. (Note that system stays in record mode only as long as play pushbutton switch is held pressed.)

If an insert edit is to be made on one or two tracks of a four-track recording, monitor one or two tracks of the tracks in Sel-Sync mode. This will aid in synchronizing the new recording with the tracks being monitored.

The on and off delay times shown in Table 3-5 can be used to anticipate when the start and stop recording times are to take place. If one of the tracks is recorded with a timing signal, such as the SMPTE time-and-control code signal, precise editing can be obtained.

**3-14. Insert Edit.** A suggested method of performing an insert edit is as follows:

1. For channel(s) to be edited, simultaneously press the channel select pushbutton switch and the READY pushbutton switch.

2. For channel(s) not to be edited, simultaneously press the channel select pushbutton switch and the SAFE pushbutton switch.

3. Rewind the tape to a point before the point to be edited.

4. Press play pushbutton switch to place system in play mode.

5. Press and hold record pushbutton switch, and then press and hold stop pushbutton switch.

6. While still holding the record and stop pushbutton switches depressed, press play pushbutton switch just prior to the edit point (Table 3-5) to start record mode.

7. Continue holding all three pushbutton switches depressed and, just prior to the end of the edit point (Table 3-5), release play pushbutton switch to stop record mode. Transport will continue to run in play mode. Release other pushbuttons and enter any mode desired. (Note that system stays in record mode only as long as play pushbutton switch is held pressed.)

# SECTION 4

# THEORY OF OPERATION

This section of the manual provides a block-diagram-oriented discussion of the functional operation of the recorder/reproducer system followed by detailed theory of operation of the recorder/reproducer and input/output assembly (accessory) circuits.

## 4-1. FUNCTIONAL DESCRIPTION OF TAPE TRANSPORT

Figure 4-1 is a simplified block diagram of the ATR-100 system. The recorder/reproducer does not incorporate a capstan pinch roller but controls tape movement in all modes of operation while under capstan servo and reel servo control. The capstan servo controls tape speed and direction while the reel servo maintains dynamically constant tape tension in all modes of operation.

Tape movement is controlled by a dc capstan motor which is controlled by a closed loop capstan servo. The capstan is driven to control tape motion but the actual work of moving the tape is accomplished by the reel servo, which operates independent of the capstan servo. Tape tension is maintained equally on the takeup and supply side of the capstan for all sizes of tape reels (2 inches through 14 inches in diameter). Since there is no difference in tape tension at the capstan, there is no tendency for tape to slip on the capstan and therefore no pressure roller (pinch roller) is required.

The actual value of tape tension is controlled by the tension arm rotary solenoids which are a component of the constant-tension arms. The solenoids are driven by direct current to result in a particular torque at the mid-position of the arm swing. These solenoids apply a near-constant force to the tension arms that are opposed by the force provided by the reels motors through the tape. The current in the solenoids is programmed and switched by the tension programming logic (located on Reel Servo PWA 9) depending on tape width, operating condition, and direction of tape movement to result in a given value of equal tape tension across the capstan.

The tension arms have an LED affixed to each arm and the light from the LED is focused onto a stationary photopotentiometer. The output from the photopotentiometer is a voltage indicative of arm position and is the servo error. Tape motion creates an unbalance or position error of the tension arm's position and, by means of a closed-loop reel servo, a tension unbalance is created in the tape path (but not across the capstan) by the reel motors. This tension unbalance causes the reel motors to perform the work of moving the tape at a rate established by the capstan. There are no independent commands supplied to the reel servo to cause such an unbalance. All control of the reels is initiated by capstan movement transmitted through the tape to the tension arm sensors.

The output from the tension arm sensors is amplified, compensated for the mechanical properties of the transport, and used to modulate a 28.8-kHz carrier to develop a pulse-width modulated (PWM) signal with a duty cycle that varies with the magnitude of the servo error signal. This PWM signal is amplified and used to drive the reel dc motors.

## 4-2. BLOCK DIAGRAM FUNCTIONAL DESCRIPTION

As shown in Figure 4-1, the ATR-100 can be configured to record and reproduce up to four audio channels. Each audio input may come from a line or other audio source, such as another tape reproducer.

## 4-3. Thread Mode

When power is applied and tape is threaded and taut so that either tape taut switch is closed, pressing the stop pushbutton switch enables the Transport Control PWA 7 logic circuitry to activate the reel servos (Reel Servos PWA 9) and place system into thread mode. After thread mode is established, any other mode may be entered.

## 4-4. Reproduce Mode

When play mode (or record mode) is selected, the capstan motor is initially driven by a fixed dc current source until a phase-lock condition is achieved, and then the motor is controlled by the output of a phase comparator (Capstan Servo PWA 8). The inputs to the phase comparator are a submultiple of a 9.6-kHz reference frequency (submultiple frequency used depends on selected tape speed) and the capstan tachometer pulses from the capstan motor assembly. As discussed in paragraph 4-1, tape movement is sensed by the supply and takeup sensors on the constant-tension arms and causes the reel servos (Reel Servo PWA 8) to control tape-reel movement.

The audio signal recovered from the tape by the record (Sel-Sync operation) or reproduce head(s) is amplified and equalized on the audio and PADNET PWA(s) and routed to the audio output for external processing, or to the optional input/output assembly for further amplification.

## 4-5. Record Mode

In the record mode, tape is moved across the heads under reel servo and capstan servo control as in play mode. During record mode, an erase signal (114 kHz) and bias signal (432 kHz) from the master oscillator on Audio Control PWA 5 are fed to the audio and PADNET PWA(s). The erase signal is fed to the erase head(s) to erase any previously-recorded signals from the tape before it reaches the record head(s). Information to be recorded is amplified, added to the bias signal, and applied to the record head(s). The information is recorded on the tape as it passes over the record head. However, actual recording on tape is not permitted to begin until the capstan servo is phase locked and a command signal is routed from the capstan servo (PWA 8) via transport control (PWA 7) and audio control (PWA 5) to the Main Audio PWA(s). After actual recording on tape has begun, bias and erase status signals are routed to the input/output assembly to cause the BIAS and ERASE confidence indicators to illuminate.

## 4-6. Spool Mode

In spool mode, capstan and reel servo operation is identical to play and record mode operation except the reference frequency furnished to the phase comparator (Capstan Servo PWA 8) from the Audio Control PWA 5 is either 9.6 kHz for 60-in/s operation, or 28.8 kHz for 180-in/s operation. In spool mode, circuitry on Reel Servo PWA 9 and transport control PWA 7 causes the tape lifter solenoid to be energized and lift the tape from the heads.

## 4-7. Shuttle Modes

In fast forward or rewind modes, the capstan is driven by a dc current driver (Capstan Servo PWA 8) rather than the phase comparator circuit. As in play, record, and spool modes, the tape movement is sensed by the supply and takeup sensors on the constant tension arms and, by means of the closed-loop reel servo, tape is moved from reel to reel.

## 4-8. Control Unit

The control unit is used to initiate all transport and signal mode functions by means of pushbutton switches which control mode latching circuits on Transport Control PWA 7 and on Audio Control PWA 5, respectively. The control unit also houses LED indicators that indicate system modes of operation. The LED indicators associated with signal mode selection are driven by multiplexer circuitry on Audio Control PWA 5.

The play, stop, record, fast forward, rewind, and edit indicators are driven by logic circuitry on Transport Control PWA 7. These indicator drives are not multiplexed.

Also located on the control unit is the tape timer display which consists of five 7-segment LED

display indicators. The transport tape timer tachometer furnishes pulses when tape is in motion to the tape timer circuitry on Transport Control PWA 7. Timer display information, in the form of a serial stream of binary-coded decimal digits, is sent to a decoder in the control unit. Digit select signals are also routed from Transport Control PWA 7 to the control unit in order to select the digit for display in the proper sequence on the tape timer LED display.

## 4-9. DETAILED THEORY OF OPERATION

Detailed theory of operation of the recorder/reproducer and input/output assembly is presented in the text that follows. Simplified functional block diagrams support the text as an aid in understanding the ATR-100 circuitry. For the complete schematic diagrams, see Section 6 of this manual.

Logic elements are identified in the text and block diagrams by their schematic reference designator and output pin number. For example, A3-1 refers to integrated circuit A3, output pin number 1. In the case where there is more than one output pin, the true (high) or active output pin designation is used.

Logic level commands used throughout the system are designated on the schematics and block diagrams by their three-letter abbreviation. All commands are a logic low, except for the LFT command and where complimentary logic is required. For example, the ready/safe command is so identified in the text but is designated $^{\text{ready}}\urcorner\!\llcorner_{\text{safe}}$ on the block diagrams. This indicates the ready command is a logic high and the safe command is a logic low. Table 4-1 is an alphabetical list (by abbreviation) of all commands used throughout the system.

Table 4-1. Command Signal Abbreviation

| ABBREVIATION | COMMAND |
|---|---|
| BCD – A – D | Binary-coded decimal drive to 7-segment decoder |
| BCS | Bias command status |
| BVS | Bias voltage status |
| CLK | Clock |
| CRB | Counter reset button |
| CS1 – 4 | Channel select buttons |
| DRC | Command direction |
| DS1 – 5 | Digit select lines |
| EDB | Edit button |
| EDI | Edit indicator |
| ERS | Electronics record status |
| EVS | Erase voltage status |
| FFB | Fast forward button |
| FFI | Fast forward indicator |
| ILM | Inner limit |
| IPB | Input button |
| ISL | Illegal speed lockout |
| LFT | Tape lift command |
| LKD | Locked |
| MRB | Main record bus |
| MTS | Motion sense |
| OLM | Outer limit |
| PDR | Play and record |
| PEC | Play edit command |
| PLB | Play button |
| PLC | Play command |
| PLI | Play indicator |
| RCB | Record button |
| RCI | Record indicator |
| RDB | Ready button |
| RED | Remote edit |
| RPB | Reproduce button |
| RWB | Rewind button |
| RWI | Rewind indicator |
| SFB | Safe button |
| SHC | Shuttle command |
| SPC | Spool command |
| SSA | Speed select A |
| SSB | Speed select B |
| STB | Stop button |
| STC | Stop command |
| STI | Stop indicator |
| STP | Stop pulse |
| SVO | Servos on command |
| SYB | Sync button |
| TDR | True direction |
| TLM | Torque limit |
| TTS | Tape taut switch |
| WUL | Wake-up line |

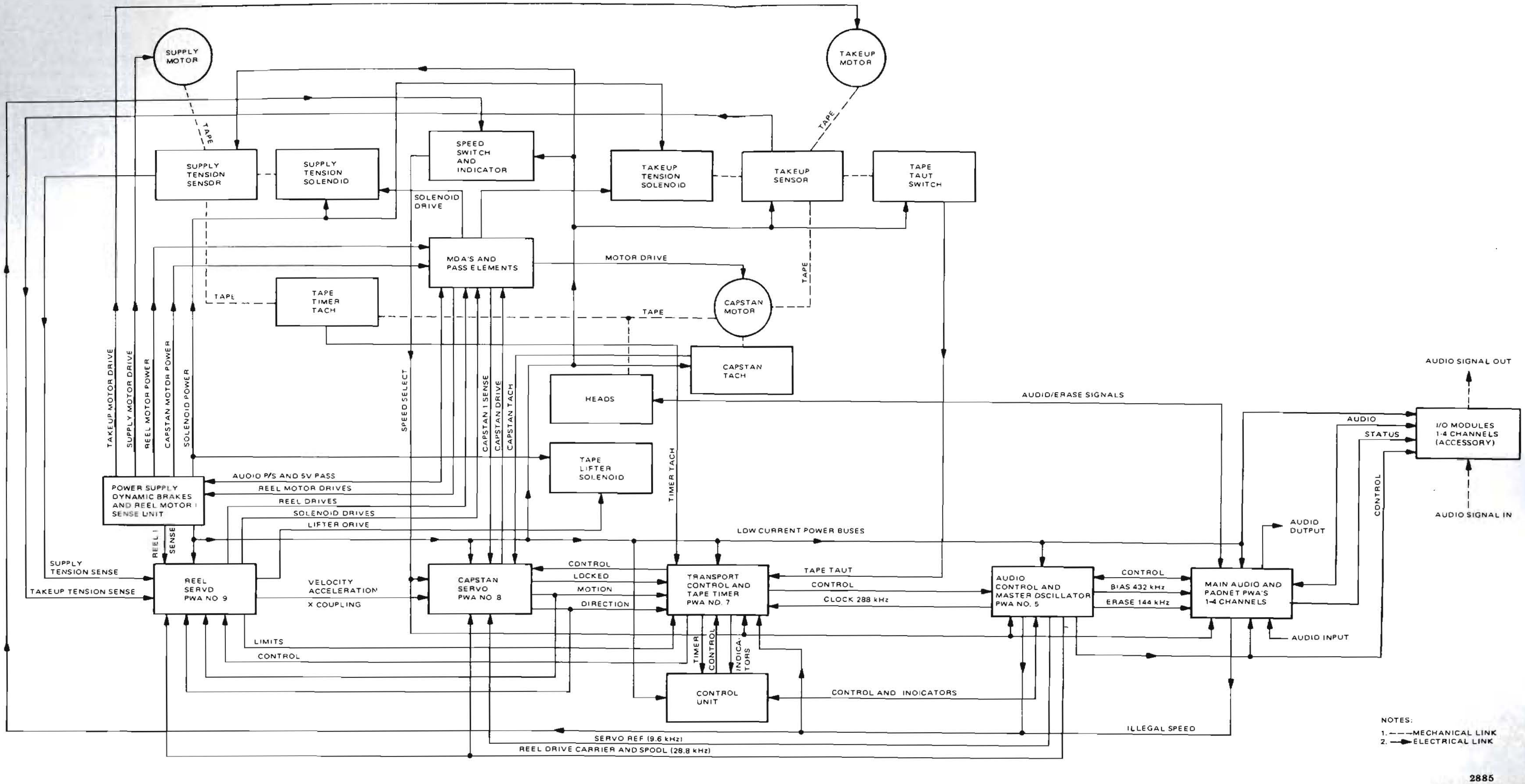



Figure 4-1. ATR-100 System, Simplified Block Diagram

## 4-10. Capstan Servo Functional Description

The capstan servo is a closed-loop type of servo that controls the speed and direction of the dc capstan motor during all recorder modes of operation. Figure 4-2 is a general block diagram of the capstan servo system. During operation, tachometer pulses are generated at a rate proportional to speed. These pulses are amplified, shaped, and fed as one input to a digital phase comparator. The other input to the phase comparator is a reference signal. This reference signal is derived from a master oscillator and determines the record, play, and spool speeds of the recorder. When the phase comparator is locked to the two signals, a rectangular-wave error signal is provided by the phase comparator. This signal is fed through a carrier filter and a compensation amplifier to a motor drive amplifier (MDA) that drives the dc capstan motor.

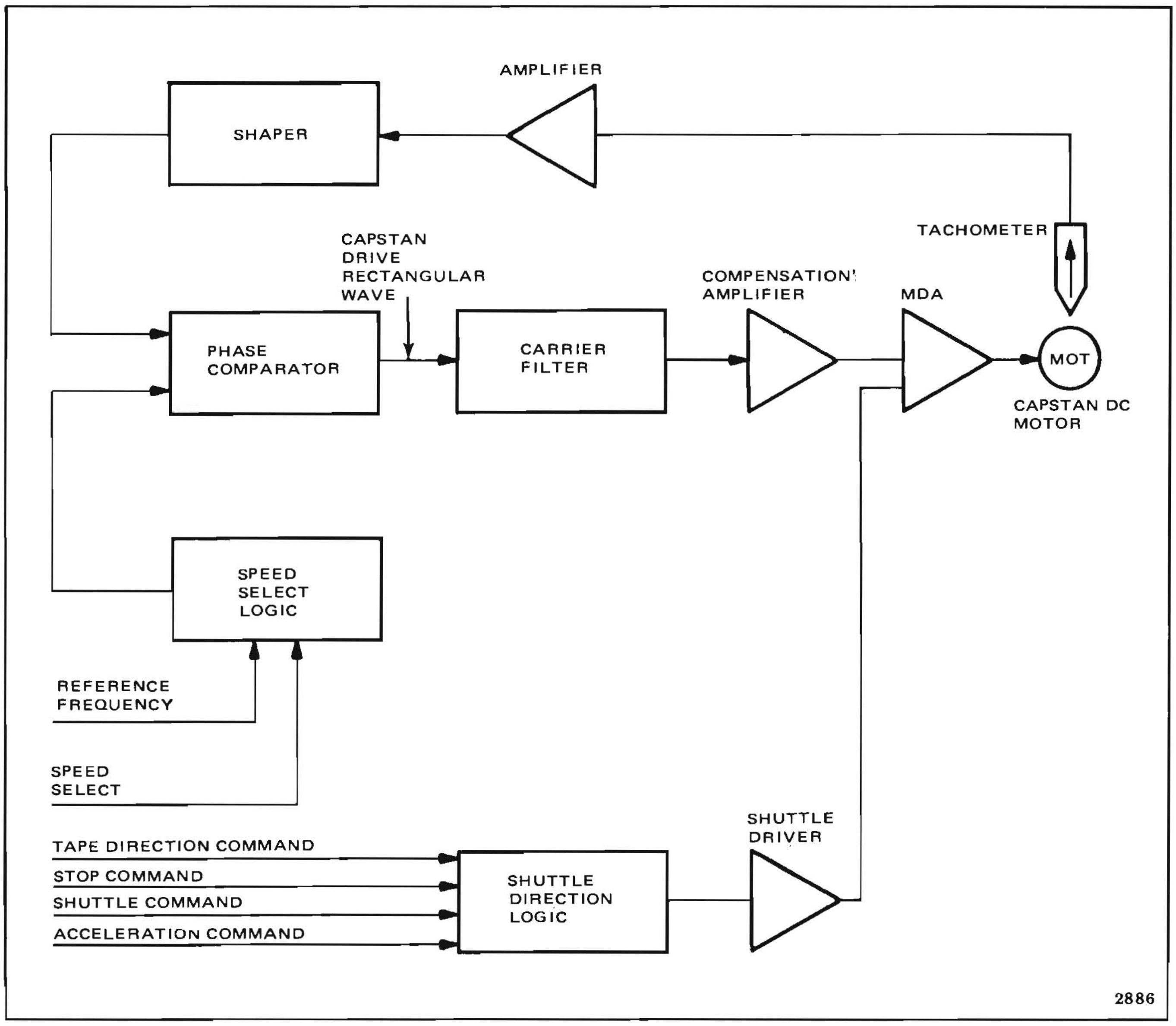



Figure 4-2. Capstan Servo General Simplified Block Diagram

In shuttle modes, initiation of stop mode, and during the initiation of play or record modes before phase lock is achieved, the capstan motor is controlled by a fixed dc current source from the shuttle driver. The direction of current flow, hence motor direction (or motor torque), is controlled by the shuttle direction logic.

### 4-11. Capstan Servo Circuit Details

The capstan servo circuitry is principally located on Capstan Servo PWA 8 and on the transport assembly. Figure 4-3 is a simplified block diagram of the capstan servo, and drawing number 4840435 is the schematic diagram.

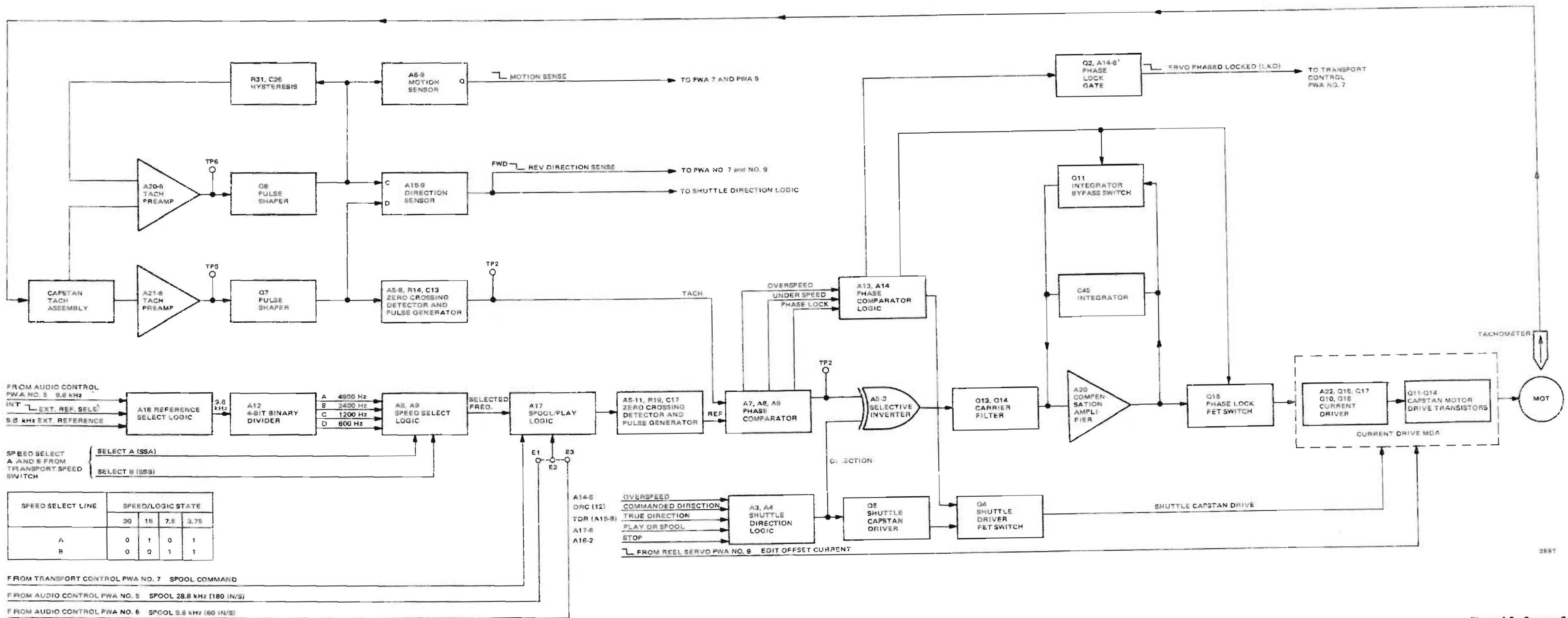
**4-12. Capstan Tach Assembly.** The capstan tach assembly provides motion sense, rotational, and direction information. A thread interlock signal enters the Capstan Servo PWA on pin 18 and leaves on pin V. If the capstan servo card is not installed the circuit is open and no transport movement is possible. The assembly contains an optical disc encoder that generates two tachometer signals as the capstan rotates. Attached to the capstan assembly is a circular glass disc encoder, approximately 2.5 inches in diameter. The disc has 1,200 clear and 1,200 opaque, equal-width segments located near the outer edge of the disc. Located above the rotating disc is a stationary encoder grating that has two groups of like segments but which are displayed 90° from each other. The patterns on the moving and fixed gratings are identical and, as the disc rotates, a shutter effect is obtained. Light from two LED's, located below the disc, is alternately blocked and allowed to pass to two photosensors located above the fixed grating.

The output signals from the photosensors are 90° out of phase and are amplified by current mode operational amplifiers A20-6 and A21-6. The amplified sine-wave signals are converted to square waves by Q6 and Q7, and applied to D flip-flop A15 which operates as a direction sensor. The output of one photosensor is clocked through the flip-flop by the output of the other photosensor. Therefore, as the capstan moves in one direction, all logic lows are clocked through and, when the capstan turns in the opposite direction, all logic high are clocked through. These outputs, indicating tape motion direction, are fed to direction logic components A3/A4 and to Transport Control PWA 7 through Q23. Hysteresis components R31 and C26 provide positive feedback from the output of Q6 to the input of A20-6 to ensure a clean pulse with a fast rise time for the clock input of flip-flop A15-9. The output of Q6 is also used to clock retriggerable one-shot A6-9, which serves as a motion sense detector. One-shot A6-9 has a long time constant (approximately 0.22 second) and does not change state as long as the capstan is turning. The output of A6-9 is fed to Transport Control PWA 7 and to Reel Servo PWA 9 to provide motion sense information.

**4-13. Phase Comparator.** The square-wave output of pulse shaper Q7 is also applied to zero crossing detector and pulse generator A5-8/R14/C13, which provides a 1-$\mu$s pulse for every transition of the square-wave input. These pulses are fed as one input to a 3-bit bi-directional shift register (A7/A8/A9) which functions as a phase comparator. The other input to the comparator is a precise reference frequency that represents the desired tape speed. The comparator compares the tach frequency with the reference frequency and provides output logic signals that indicate whether the servo is in an underspeed, overspeed, or phase-locked condition. The logic states of these output signals are summarized in Table 4-2. When the phase error is less than 360°, a rectangular wave with a varying duty cycle (depending on the capstan servo error) is present at A8-6. This rectangular wave is used to drive the capstan MDA, via a carrier filter and compensation amplifier, when the phase comparator is locked to the reference signal. The other output lock signals are used to control logic functions described later.

When the phase comparator is locked, A13-6 is low, Q2 does not conduct, and A14-6 provides a logic low that signifies the phase comparator is locked. This signal is routed to Transport Control PWA 7 to enable the play and record modes of operation.

**4-14. Speed Reference Frequency.** The phase comparator compares the phase of the signal from the capstan tach reader to a submultiple of the 5.184-MHz signal from the master oscillator located on Audio Control PWA 5. For play or




| SPEED SELECT LINE | SPEED/LOGIC STATE | | | |
|---|---|---|---|---|
| | 30 | 15 | 7.5 | 3.75 |
| A | 0 | 1 | 0 | 1 |
| B | 0 | 0 | 1 | 1 |

Figure 4-3. Capstan Servo Simplified Block Diagram

Table 4-2. Phase Comparator Output Logic States

| GATE | SERVO CONDITION | | |
|---|---|---|---|
| | UNDERSPEED | OVERSPEED | PHASE LOCKED |
| A9-6 | H | L | H |
| A7-11 | L | H | H |
| A14-8 | L | H | L |
| A14-11 | H | L | H |
| A13-6 | H | H | L |
| A14-3 | H | L | L |
| A13-12 | H | L | L |

Table 4-3. Tape Speed Reference Frequencies

| TAPE SPEED (IN/S) | MODE | REFERENCE FREQUENCY |
|---|---|---|
| 180 | Spool | 28.8 kHz |
| 60 | Spool | 9,600 Hz |
| 30 | Play/Record | 4,800 Hz |
| 15 | Play/Record | 2,400 Hz |
| 7.5 | Play/Record | 1,200 Hz |
| 3.75 | Play/Record | 600 Hz |

record modes, a submultiple of 9,600 Hz is used; and for spool mode, 9,600 Hz or 28.8 kHz is used. These reference frequencies and associated tape speeds and recorder modes of operation are shown in Table 4-3.

As shown on simplified block diagram Figure 4-3, a 9,600-Hz reference signal from Audio Control PWA 5 or an external source is applied to the reference select logic A18. A command signal routed from accessory connector J11 selects either the internal or external reference signal, and the selected signal is applied to the clock input of 4-bit binary divider A12. When play or record mode is selected, the divider is enabled by a low applied to its reset inputs. The 9,600-Hz signal is divided down (4,800 Hz, 2,400 Hz, 1,200 Hz, and 600 Hz) and applied to the play/record speed select logic (A10/A11-8). The speed select signal, in the form of a 2-bit binary encoded signal from the transport speed select switch is applied to the input of the speed select logic A10/A11. The speed select logic permits the selected frequency to pass to the spool/play-record select logic (A17). When in play or record mode, gate A17-8 is enabled and passes the selected frequency to zero crossing detector and pulse generator A5-11/R19/C17. The generator provides a 1-μs positive-going pulse for each transition of the reference square-wave signal. These pulses are applied as the reference signal for the phase comparator.

For selection of spool speed, a jumper on PWA 8 is positioned to select 60 or 180 in/s (during recorder installation). These speeds correspond to a reference frequency of 9,600 Hz or 28.8 kHz, respectively. When spool mode is selected, a low command signal is applied to the spool/play-record

Table 4-2. Phase Comparator Output Logic States

| GATE | SERVO CONDITION | | |
|---|---|---|---|
| | UNDERSPEED | OVERSPEED | PHASE LOCKED |
| A9-6 | H | L | H |
| A7-11 | L | H | H |
| A14-8 | L | H | L |
| A14-11 | H | L | H |
| A13-6 | H | H | L |
| A14-3 | H | L | L |
| A13-12 | H | L | L |

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| TAPE SPEED (IN/S) | MODE | REFERENCE FREQUENCY |
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| 3.75 | Play/Record | 600 Hz |

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For selection of spool speed, a jumper on PWA 8 is positioned to select 60 or 180 in/s (during recorder installation). These speeds correspond to a reference frequency of 9,600 Hz or 28.8 kHz, respectively. When spool mode is selected, a low command signal is applied to the spool/play-record

select logic (A17) to lockout the play/record frequencies and enable the preselected (jumper) spool frequency. The enabled spool frequency is applied to the zero crossing detector and pulse generator as in play/record modes.

**4-15. Direction Logic and MDA Driver.** Direction logic A3/A4 accepts input signals from five sources and determines what the polarity of the capstan motor drive voltage should be for the various recorder modes of operation. These input signals are from the phase comparator logic A13/A14; direction sensor A15-9; and the spool, play, and shuttle direction commands from Transport Control PWA 7. The output of the shuttle direction logic (A4-11) is a logic high for forward direction and a logic low for reverse direction. For shuttle modes, for initiation of play or record mode before phase lock is achieved (underspeed condition), and for capstan drive to stop, the level from A4-11 is inverted by A19-6 and applied to shuttle driver Q5 which translates the logic level to +5 Vdc for a forward direction motor rotation and –5 Vdc for reverse direction motor rotation. This voltage level is routed through FET switch Q4, which is enabled by the phase detector logic, to the capstan MDA to drive the capstan motor.

It should be noted that these voltage levels do not necessarily result in the capstan turning in the particular direction of the drive signal, but are sometimes used to stop rotation. For example, when fast forward mode is in operation and a stop command is given, the drive signal polarity is reversed to stop the capstan rotation.

For play, record, or spool modes of operation, the output of the direction logic (A4-11) is applied to EXCLUSIVE OR-gate A5-3 to control the polarity of the rectangular wave output from the phase detector.

**4-16. Capstan Motor Edit Offset.** In stop/edit mode of operation, power is removed from the takeup reel and the tension arm roller is pressed against the capstan. To prevent the supply reel holdback tension from pulling the capstan backwards when capstan drive power is removed, a current is sourced into the capstan MDA summing node (pin 6 of A22-7). A low play/edit command (PEC) from Transport Control PWA 7 is inverted by A14-2 on Reel Servo PWA 9 and is routed through R124 as an edit-offset current to the capstan MDA on Capstan Servo PWA 8.

**4-17. Play Mode.** When play (or record) mode is selected, the capstan motor is initially driven by the shuttle driver (underspeed condition) until phase lock is achieved. After phase lock is achieved, control of the motor is switched to the output of the phase comparator. (See *Direction Logic and MDA Driver*, paragraph 4-15.)

**4-18.** *Underspeed Condition.* To prevent motor overshoot when the servo switches to phase-lock control, the compensation amplifier integrator capacitor (C49) is disabled by shunt switch Q11 during motor acceleration. A logic high from the phase detector logic (A14-3) turns Q11 on during the underspeed condition. Also the phase detector logic provides a high (A14-3) to turn FET switch Q15 off, and a high (A13-12) to turn FET switch Q4 on. When Q15 is off, the compensation amplifier output is disconnected from the MDA, and when Q4 is on, the capstan motor is driven by shuttle capstan driver Q5. Then on/off state of the FET switches is summarized in Table 4-4.

**4-19.** *Phase Lock.* When phase lock is achieved, the phase detector logic turns Q4 and Q11 off, and turns Q15 on. Then the MDA drive signal path is from the phase detector through EXCLUSIVE OR-gate A5-3, carrier filter Q13/Q14, compensation amplifier A22-1, to the capstan MDA.

**4-20. Spool Mode.** For spool mode operation, the circuit operation is identical to play mode operation except for the reference frequency furnished to the phase comparator. For 180-in/s operation, the spool speed jumper is placed in position E1/E2 to select 28.8 kHz as the reference frequency. For 60-in/s operation, the jumper is placed in position E2/E3 to select 9,600 Hz as the reference frequency. As in shuttle or play modes of operation, spool direction is controlled by the output of the shuttle direction logic (A4-11).

**4-21. Stop Mode.** When the stop mode is selected from any other mode of operation, the capstan servo is placed in the opposite shuttle mode from which the tape is moving until the tape

Table 4-4. Capstan Servo FET Switch Control

| SERVO CONDITION | INTEGRATOR BYPASS SWITCH Q11 | PHASE LOCK SWITCH Q15 | SHUTTLE DRIVER SWITCH Q4 |
|---|---|---|---|
| UNDERSPEED | ON | OFF | ON |
| OVERSPEED | OFF | ON | OFF |
| PHASE LOCKED | OFF | ON | OFF |
| STOPPED | OFF | OFF | OFF |

slows to approximately 0.5 in/s. Then the capstan drive power is removed from the MDA.

When the tape is moving and a stop command is entered, the output of the shuttle direction logic (A4-11) causes the MDA to attempt to drive the capstan in a direction opposite to that which it is going. While the tape is still moving, 1.0-$\mu$s pulses from A5-8 are applied to retriggerable one-shot A6-7 which has a short time constant. When the tape almost stops, A6-7 changes state and resets latch A15-5. The low from A15-5 and the low in overspeed from the phase comparator logic turns FET switch Q4 off. When Q4 turns off, capstan MDA power is removed and the tape comes to a stop.

## 4-22. Reel Servo Functional Description

The reel servo is a closed loop servo that controls the reel motors to maintain constant tape tension across the heads in all modes of operation. Figure 4-4 is a simplified general block diagram of the reel servo system.

The reel servo is not concerned with how much tape is on a reel (as in an open-loop reel servo) but only with what the tape tension is on either side of the capstan. These tensions must be equal in all modes of operation. The tensions are sensed by the position of tension arms which are positioned by the tape. All tape motion is controlled by the capstan, and the reel servo supplies and takes up tape based on information the servo receives from the tension arm sensors. *The actual value of tape tension is controlled by the tension arm solenoids.* The solenoids apply a near-constant force to the tension arms, that is opposed by the force provided by the reel motors through the tape. This value of tape tension is established by the tension logic and depends on a given operating condition. When the reel servo is activated (pressing the stop pushbutton with tape threaded and taut), the tension arm solenoids and reel motors are activated. The tension arm has an LED affixed to the arm and the light from the LED is focused on a stationary photopotentiometer. The output from the photopotentiometer is a voltage proportional to arm position and is the servo error.

This servo error voltage, which is amplified and compensated, is used to modulate a 28.8-kHz carrier frequency to develop a pulse-width modulated (PWM) signal with a duty cycle that varies with the magnitude of the servo error signal. The PWM signal is fed through a gate, used to turn the reel servo on and off, to a dual-polarity, motor drive amplifier driver, which amplifies the TTL level signal to a level suitable for driving the MDA switching transistors. The switching transistors alternately switch positive and negative 20 Vdc across the motor at a 28.8-kHz rate. Because of the inductance of the dc motor, the 28.8-kHz signal is filtered and only the dc component of the current remains of significance. Motor torque is proportional to the current in the motor. When the duty cycle is exactly 50%, the dc current in the motor is zero and the motor does not turn.

## 4-23. Reel Servo Circuit Details

The reel servo circuitry is principally located on Reel Servo PWA 9 and on the transport assembly. Figure 4-5 is a simplified block diagram of the reel

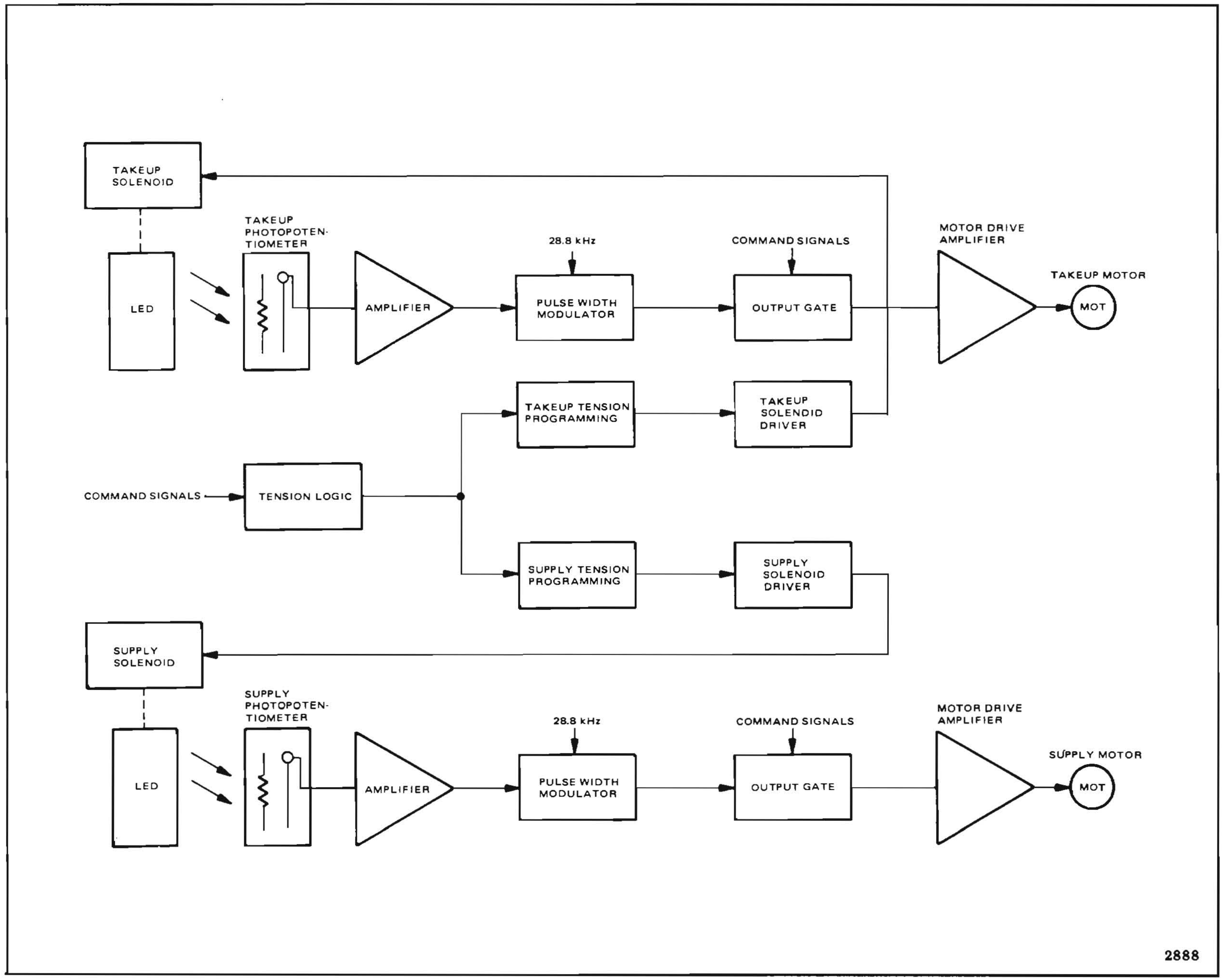


**Figure 4-4. Reel Servo General Simplified Block Diagram**

servo and drawing 4840395 (Section 6) is the schematic diagram.

**4-24. Takeup and Supply Tension Sensors.** Tension arm position is sensed by light from an LED shining on a photopotentiometer. Light from an LED attached to each arm is focused on an associated stationary photopotentiometer and causes a voltage to be sensed, corresponding to the position of the tension sensor arm. The total voltage range is approximately +2.0 to –2.0 Vdc when the arm is moved from one extreme to the other. Under actual servo conditions, the voltage may change only a few tenths of a volt. When the recorder is in the thread condition, the force on the tension arms from the reels (through the tape) is balanced by the torque exerted by the tension arm solenoids (discussed later).

**4-25. Compensation Amplifier.** The takeup and supply reel servos are similar in operation; therefore, only the takeup reel servo is described. The output dc voltage (error signal) from the takeup photopotentiometer is routed from the transport to feedback compensation amplifier A2-7, which amplifies the error signal and provides compensation for the mechanical properties of the transport. When tape is threaded on the transport and prior to the initiation of thread mode (pressing the stop pushbutton), the tension arms are held by light spring pressure in the maximum up (toward the reels) position. This results in a large servo error when the servo is activated. To prevent tape from being spilled when the reel servos are activated, the gain of the compensation amplifier is temporarily reduced in the reel unwind direction (supply reel counterclockwise, takeup reel clockwise). A logic low torque limit command (TLM) from Transport Control PWA 7 causes FET switch Q3 to turn on and increase the feedback around amplifier A2-7. This reduces the amplifier output in the unwind direction as determined by the voltage drop of diode CR4. After thread mode is obtained and the servo is engaged, the torque limit command is removed and full gain is restored.

**4-26. Pulse-Width Modulator.** The amplified and compensated signal from feedback amplifier A2-7 is used to modulate a 28.8-kHz carrier signal from Audio Control PWA 5. These two signals are applied to the summing input of pulse-width modulator (PWM) A1-7. The integrating characteristics of the modulator produce a triangular waveform summed with the error signal from amplifier A2-7 (see waveform Figure 4-6). The composite signal is applied to amplifier/limiter Q5 that amplifies and clips the signal to produce a rectangular waveform with transitions corresponding to the zero crossings of the summed signals. The rise time of the rectangular waveform is decreased by gate A6-12 and results in a clean waveform occurring at a 28.8-kHz rate with a duty cycle that is a function of the error signal. When there is zero servo error, the duty cycle is 50% and the reel motors stand still.

**4-27. Output Gates and MDA.** The pulse-width modulator signal from A6-12 is fed to the input of output gate A5-6 and through inverter A6-10 to output gate A5-8 to produce two 180° out-of-phase MDA signals. The MDA is a switching type power amplifier. Because of a residual charge that remains on the base of the switching transistors after the drive signal has turned off, the transistors do not turn on and off instantly. Therefore, without correction, it is possible that opposite polarity MDA drive signals can be on at the same time and cause overheating of the output switching transistors (Q1 through Q4). To prevent this situation, the signal from A6-12 is also fed to dead zone generator R34/CR10/C7 and through A6-10 to dead zone generator R33/CR9/C6. The generators modify the PWM signals, and the modified and unmodified signals are combined in gates A5-6 and A5-8 to produce a MDA drive signal with a dead zone as shown in Figure 4-7.

The takeup and supply reel servos are turned on by the logic low reel servo on command (SVO) from Transport Control PWA 7. The logic low is inverted by gate A14-12 and enables gates A5 and A7. In play/edit mode, power is removed from the takeup reel only. A logic low play/edit command (PEC) from Transport Control PWA 7 disables gates A5-6 and A5-8 which prevents the 28.8-kHz MDA drive signal from reaching the MDA.

When gates A5-6 and A5-8 are enabled, opposite phase 28.8-kHz MDA drive signals are fed through the MDA drive transistors (Q7/Q9/Q15 and Q6/Q8/Q14) to the MDA switching transistors Q1/Q2 located on the heat sink area of the transport

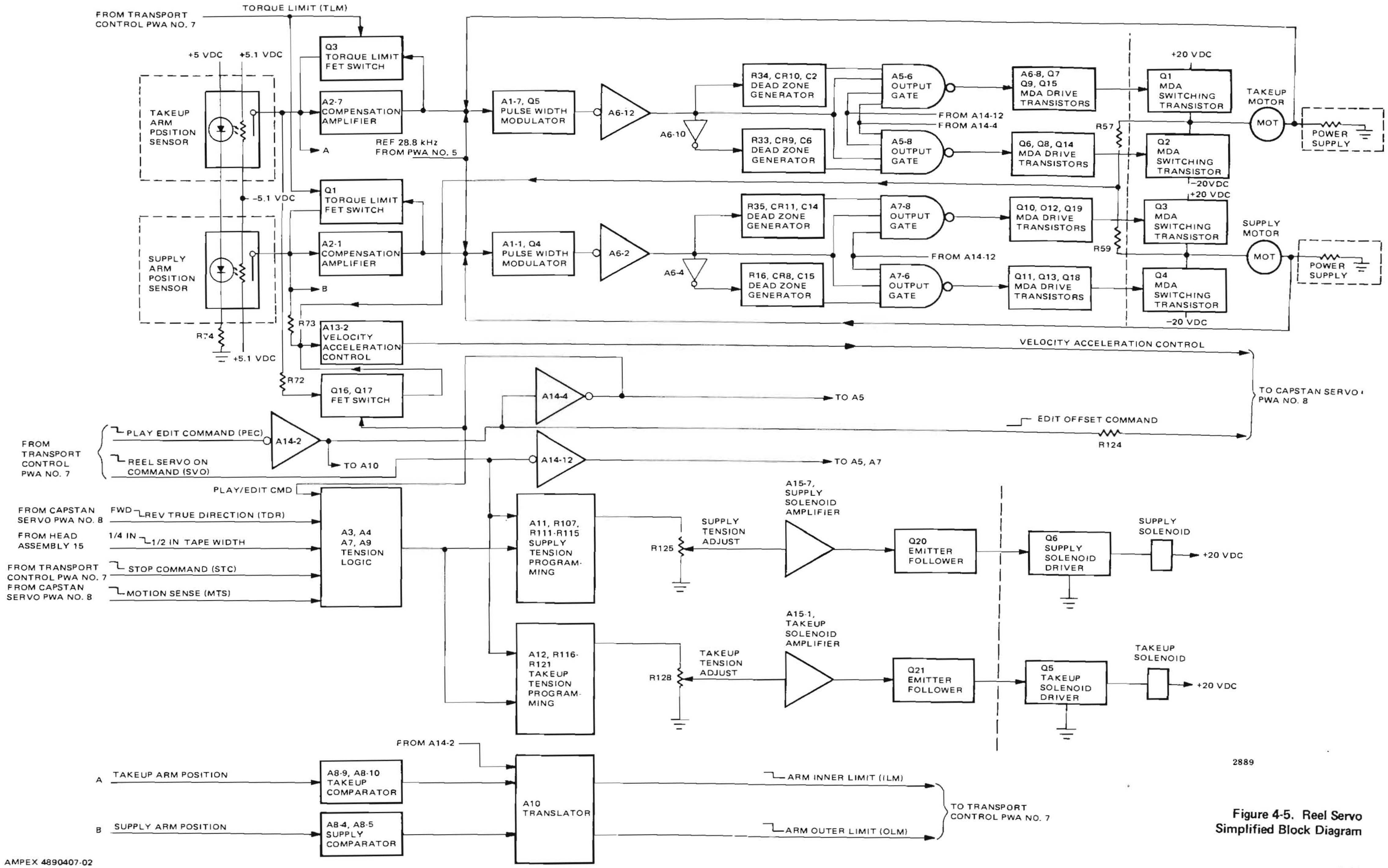


Figure 4-5. Reel Servo Simplified Block Diagram

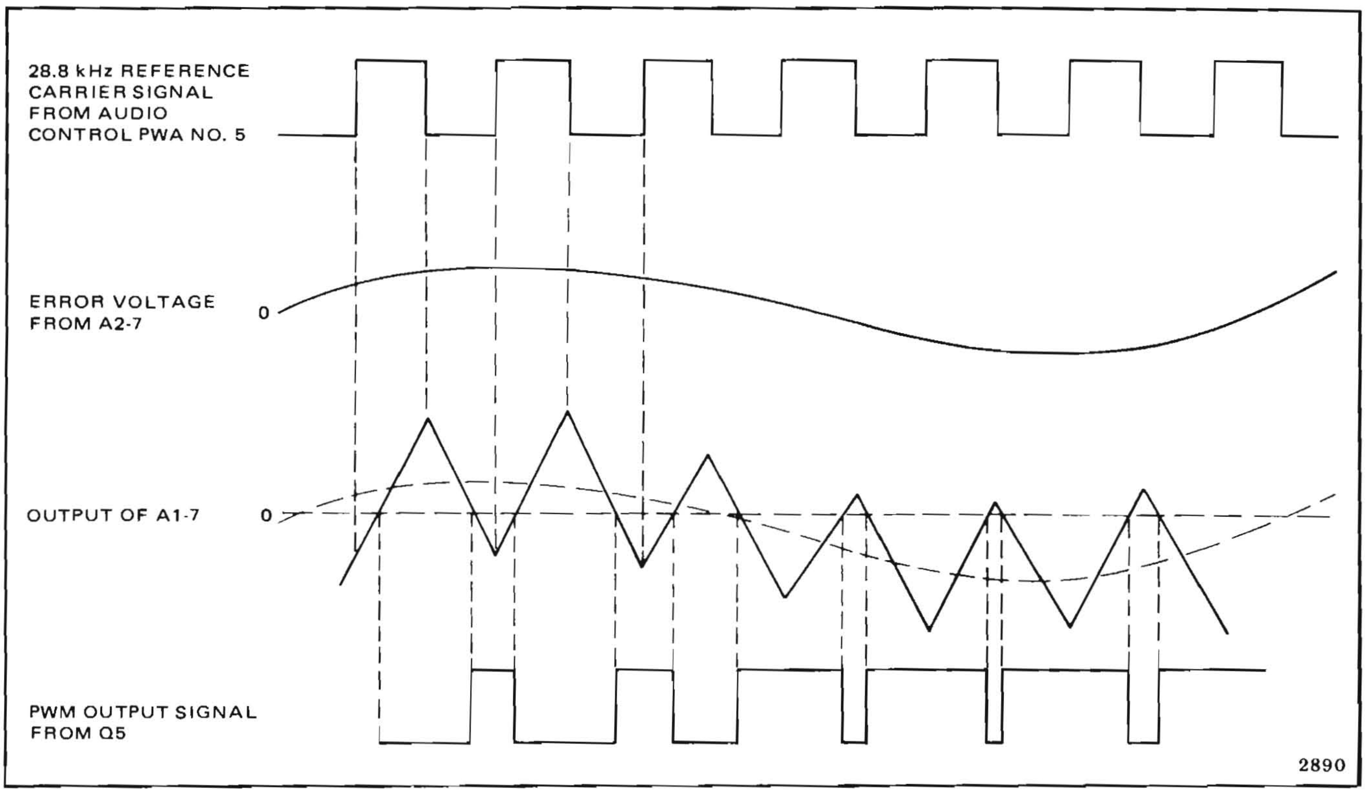


Figure 4-6. Pulse Width Modulator Waveforms, Takeup Reel Servo

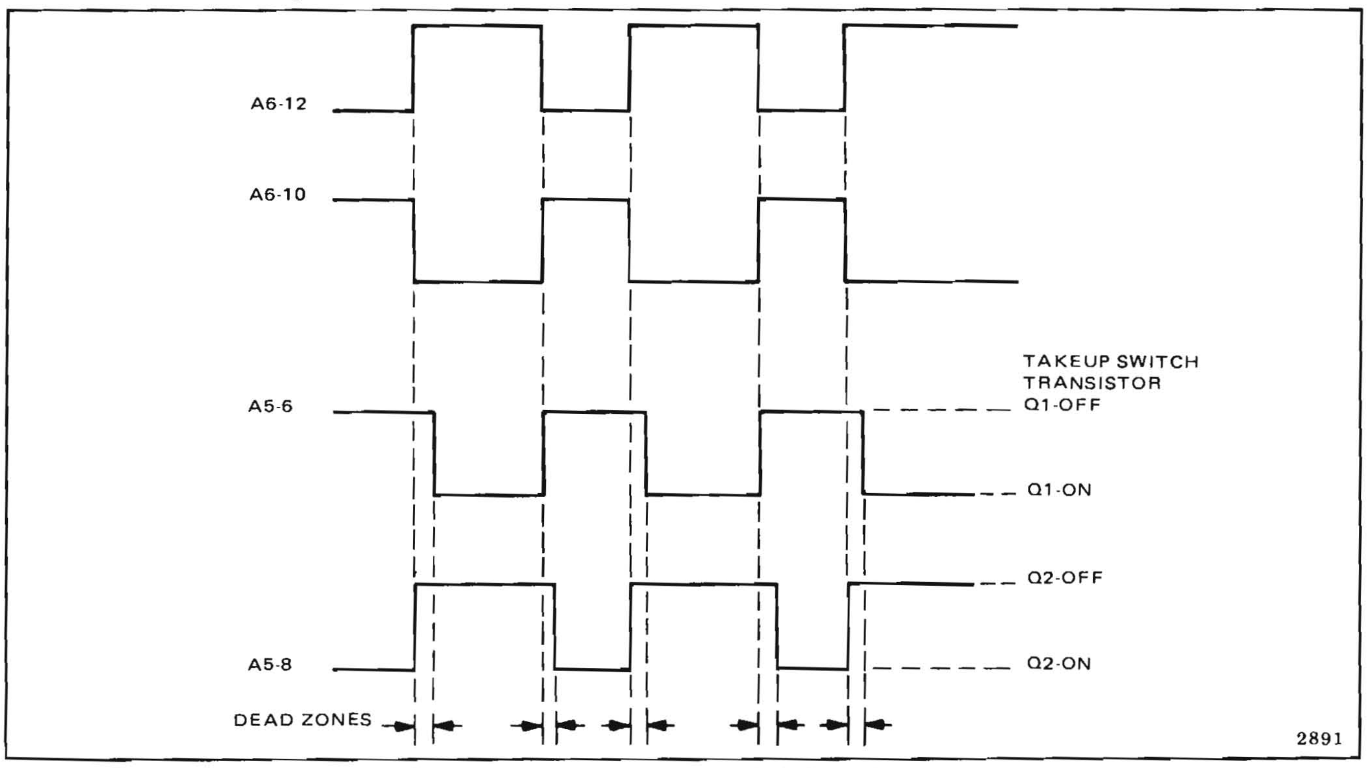


Figure 4-7. Dead Zone Generator Operation and MDA Switch Transistor Conduction State

casting. The transistors are alternately switched on and off to provide a +20V and –20V drive across the reel drive motor. As shown in Figure 4-7, switching transistor Q1 or Q2 conducts when the output at A5-6 or A5-8, respectively, is in a low state.

The output current of the drive motor is sampled across a 0.1-ohm resistor located in the power supply. The dc component of the sampled signal provides feedback and is applied to the inverting summing input of pulse-width modulator A1-7 to enable the modulator/MDA to be a current source for the motor. For any given error voltage, the feedback provides for constant motor torque at all operating speeds.

**4-28. Tension Arm Limit Detector.** During recorder operation, if the tension arms should move too far in toward the head assembly (inner limit—ILM) or too far out toward the reels (outer limit—OLM), a logic low ILM or OLM command is generated. These commands are routed to Transport Control PWA 7. The ILM command causes the recorder to immediately enter the stop/edit mode and the OLM command causes the recorder to enter the stop/edit mode after an approximate two-second time delay.

The operation of the takeup and supply tension arm limit detectors are similar in operation, therefore only the takeup detector circuit is described. The voltage sensed by the photopotentiometer is routed to the non-inverting and inverting input of comparators A8-9 and A8-10 respectively. These comparators are referenced to a zener-controlled reference voltage source. When a tension arm limit voltage is exceeded, the associated comparator changes state and applies +12 Vdc to monolithic transistor array A10, which serves as a translator. The translator provides a logic low ILM or OLM command which is routed to Transport Control PWA 7.

During play/edit mode, the takeup tension arm roller is pressed against the capstan. In this mode the takeup arm ILM command is disabled. The logic low play edit command (PEC) is inverted by A14-2 and is applied to transistor A10-4. The transistor turns on and disables the output from comparator A8-9. This causes the ILM command to remain in a high (inactive) state. (The supply tension arm ILM command is still functional.)

**4-29. Tension Logic.** The tension arms exert a constant selected force against the tape, which is balanced through the tape by the torque from the reel motors. This tension has to be the same on the supply and takeup side of the capstan during all modes of operation to prevent tape slippage across the capstan. The tension logic (A3/A4/A7/A9) accepts input signals from six sources and determines what the tape tension should be for a given operating condition. These logic input signals are: motion sense (MTS), stop command (STC), tape width (1/4- or 1/2-inch tape), forward or reverse true direction (TDR), play/edit command (PEC), and reel servo on command (SVO). When 1/2-inch tape is used, the tensions are doubled in forward and reverse modes, but the tension is the same as for 1/4-inch tape when the tape is stopped or when in play/edit mode.

The tension logic performs combinational logic functions and the output is fed to the tension programming. The tension programming consists of six open collector inverters (A11) and associated pull-up resistors (R107 and R112 through R115) for the supply tension; and A12 and R116 through R118, R120, and R121 for the takeup tension. In operation, one of the pull-up resistors is switched into a voltage divider circuit in conjunction with R111 (supply) or R119 (takeup). To select a particular tension, a gate is enabled and the output signal is inverted. The low at the output of the inverter provides a ground return for the selected pull-up resistor. The voltage at the junction of the pull-up resistor and R111 (supply) or R119 (takeup) is applied through a tension adjustment potentiometer R125 (supply) or R128 (takeup) to an operational amplifier A15-7 (supply) or A15-1 (takeup) where the voltage is converted to drive current for the respective tension solenoid.

In the electrical unthread condition, SVO is inactive (high), A11-8 and A12-6 are low, and zero volts is applied to the input of the operational amplifiers. This results in zero current drive to the solenoids. In play/edit mode, all A12 outputs are high. This results in maximum drive to the takeup solenoid and the tension arm roller is pressed against the capstan.

**4-30. Velocity/Acceleration Control.** During capstan servo underspeed and overspeed condition and shuttle modes of operation, a velocity/acceleration control signal is developed on the Reel Servo PWA and is routed to the Capstan Servo PWA 8 to slow the acceleration or velocity of the capstan motor. For example, when small diameter hub reels are used during shuttle mode, the capstan may require the reel motors to turn faster than the available reel motor voltage permits. The velocity/acceleration control circuitry senses this situation and generates an analog voltage that is used to prevent the capstan from turning faster than allowed by the reel size. Similarly, when using 14-inch reels, the velocity/acceleration control signal prevents the capstan motor from accelerating faster than the reel motors can supply or take up the tape.

The velocity/acceleration control signal is developed as follows. The voltage developed across the reel motors, which is proportional to reel velocity, is sampled by R57 and R59 and applied to the summing input of operational amplifier A13-6. Also, the voltage from both tension arm photopotentiometers, which is proportional to the difference in acceleration between the reels and the capstan, is sampled by R72 and R73 and applied to the summing input of A13-6. The four signals are summed and the output of A13-6 is phase compensated by C28/C29/R68 for mechanical properties of the system. The compensated signal is routed to the Capstan Servo PWA 8.

In play/edit mode, the input from the takeup tension arm sensor is switched off by FET Q16. This is necessary as the output from the takeup photopotentiometer indicates a large acceleration error which would result in the capstan not starting to rotate. FET switch A13-6 is activated by the play/edit command from Transport Control PWA 7.

**4-31. Edit Offset Command.** A low play/edit (PEC) from Transport Control PWA 7 is inverted by A14-2 and is routed through R124 to the capstan MDA on Capstan Servo PWA 8. (See *Capstan Motor Edit Offset*, paragraph 4-16.)

**4-32. Dynamic Emergency Braking.** In the event of primary power removal or loss of reel servo control while the reels are in motion, the trailing reel is braked to a stop by dynamic emergency braking. (Dynamic braking is employed as the recorder does not have mechanical brakes.)

The takeup and supply reel brake systems are identical in operation; therefore, only the takeup brake system is described. Figure 4-8 is a simplified schematic diagram of the takeup dynamic brake system. When tape is threaded on the recorder and thread mode is entered (pressing the stop pushbutton), the reel servo on command (SVO) goes low and causes Q9 to turn off and Q10 to turn on.

When Q10 turns on, brake relay K1 is energized and power is provided to the takeup motor from the MDA switching transistors via relay contacts 5 and 9. In the event of primary power removal or loss of reel servo control (SVO goes high), relay K1 de-energizes and causes relay contacts 5 and 9 to open, and contacts 2 and 9 to close. If the tape is moving in the rewind direction, steering diode CR13 will conduct and connect lamp DS-1, via relay contacts 2 and 9, across the trailing motor. The coasting motor generates a current through the lamp and results in dynamic braking within the motor until the reels come to a stop. Thus the kinetic energy contained in the moving reels is dissipated.

**4-33. Transport Control PWA 7**

Transport Control PWA 7 accepts input commands from the recorder control panel (or remote recorder control panel) and status signals from other circuits within the recorder system, and performs combinational logic functions. These combinational logic functions are performed by inverters, latches (cross-coupled gates), NAND gates, and time delay circuits to provide logic level command signals that are used to control all transport functions and modes of operation. All input and output commands are a logic low, except for the LFT command (see paragraph 4-9) and where complimentary logic is required. For example, forward tape motion—logic high, reverse tape motion—logic low. These commands are identified in the text and on the schematics by their three-letter abbreviation. (See Table 4-1 for a complete list of abbreviations.)

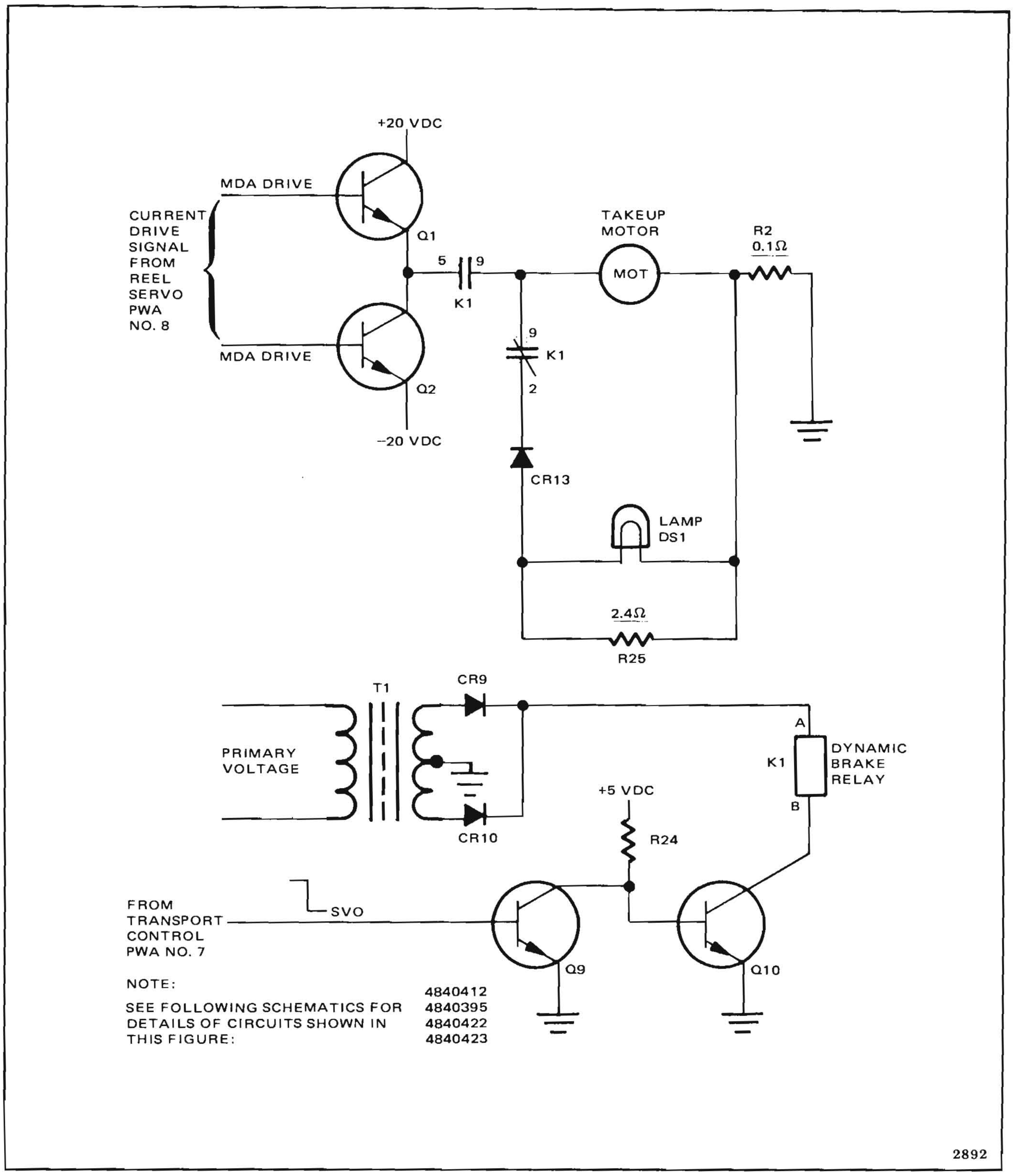


Figure 4-8. Takeup Dynamic Brake, Simplified Schematic

Figure 4-9 is a simplified functional block diagram of Transport Control PWA 7 and drawing 4840397 (Section 6) is the schematic diagram.

**4-34. System Wakeup Circuit.** Transistors Q1, Q2 and associated components comprise a system wakeup circuit that causes the recorder to enter the stop/edit (unthread) mode when power is turned on. This circuit also causes all signal channels to enter safe and repro modes; SAFE, REPRO, stop, and EDIT indicators to light; and the tape timer to be reset and indicate 0 00 00.

When power is first applied, capacitor C12 begins to charge through R11 and apply base current to Q2, causing the transistor to turn on. This causes Q1 to turn on and provide a logic low wakeup command (WUL). After approximately five seconds, C12 is charged and causes Q2 to turn off, which causes Q1 to turn off, and the WUL line goes high.

In the event power is lost and reapplied before the cycle is completed, CR7 quickly discharges C12 to permit a complete wakeup cycle when power is applied.

**4-35. Control Circuit Operation.** A mode of operation is selected by pressing a pushbutton switch on the recorder control panel. Pressing a pushbutton switch generates a logic low that sets an associated latch. These latches are interconnected to make the operation mutually exclusive so that only one mode may be engaged at a time. The output of the latch also causes the associated LED indicator to illuminate. All indicators are activated by a logic low applied through a 390-ohm resistor (located in the control unit) to the cathode of the LED. The anode of the LED is connected to +5.0 Vdc. These indicators are rewind (RWI), fast forward (FFI), stop (STI), and edit (EDI). The play indicator (PLI) is activated by a logic low locked (LKD) signal from Capstan Servo PWA 8, and the record indicator (RCI) is activated through two inverters by the electronic record status (ERS) signal from Audio Control PWA 5.

**4-36.** *Rewind and Fast Forward Mode.* Rewind or fast forward mode (shuttle mode) is entered when the respective pushbutton is pressed. When the rewind pushbutton is pressed, direction latch A4-8/A10-12 and shuttle latch A10-8/A16-8 are set. The logic high from the direction latch is inverted by A29-6 and a logic low signifying reverse direction is routed to the Capstan Servo PWA 8 to cause the capstan to rotate in the rewind direction when the shuttle command is received.

When the fast forward pushbutton is pressed, the direction latch is reset and a logic high is routed to the capstan servo to cause the capstan to rotate in the forward direction. When either pushbutton is pressed, the shuttle latch (A10-8/A16-8) is set and causes a logic low shuttle command (SHC) to be routed to the capstan servo. This command enables the shuttle drive circuitry.

**4-37.** *Spool Mode.* Spool mode is entered when the play and either the rewind or fast forward pushbutton switches are simultaneously pressed. Under these conditions, gate A11-3 is enabled and causes spool latch A11-11/A11-8 to set. The low output from A11-8 is inverted by A17-6 and enables gate A29-12, which generates a logic low spool command (SPC) that is routed to the Capstan Servo PWA 8.

**4-38.** *Tape Lifter Operation.* The tape lifters lift the tape away from the heads in rewind and fast forward modes (shuttle modes) and spool modes. In shuttle modes, the low from shuttle latch A16-8 is inverted by A17-8 and enables shuttle gate A29-8. The low from A29-8 is inverted by A34-11 to set tape lifter latch A22-8/A28-6. The high from A22-8 enables gate A28-8 and the low from A28-8 is inverted by A38-6. When A38-6 is high (LFT), the tape lifter solenoid is energized and the tape is lifted from the heads. (Note: This is the only high logic-state command in the system.)

In spool modes, the low from A11-8 of the spool latch is inverted by A17-6 and enables spool gate A29-12. The low from A29-12 is inverted by A34-11 and A23-8 to set tape lifter latch A22-8/A28-6 which causes the tape lifter solenoid to be energized (LFT logic high) by the same circuit action as described for shuttle modes.

If shuttle or spool mode is active, pressing the EDIT pushbutton causes the tape lifters to retract (solenoid de-energizes) and the tape to contact

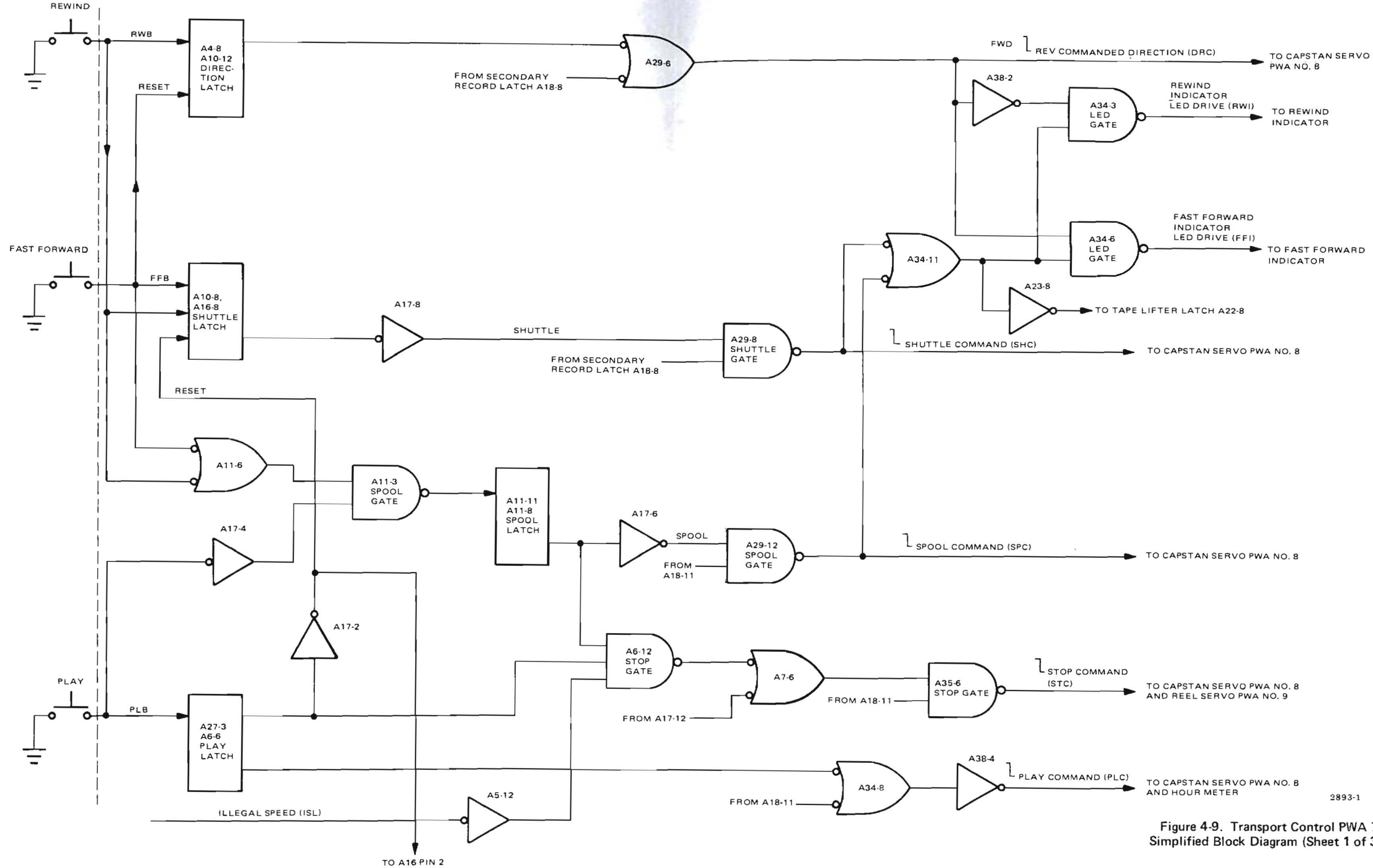


Figure 4-9. Transport Control PWA 7, Simplified Block Diagram (Sheet 1 of 3)

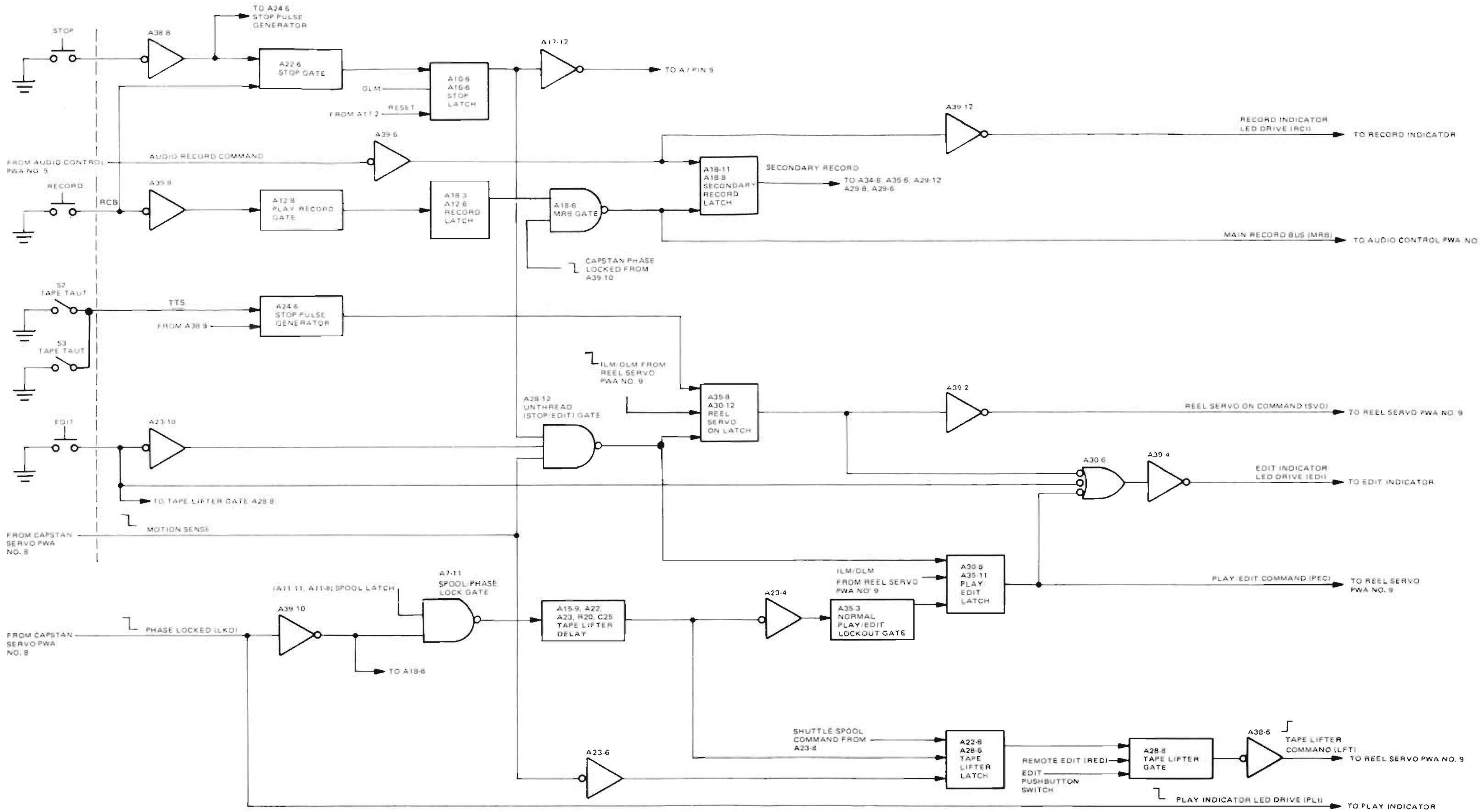

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Figure 4-9. Transport Control PWA 7, Simplified Block Diagram (Sheet 2 of 2)

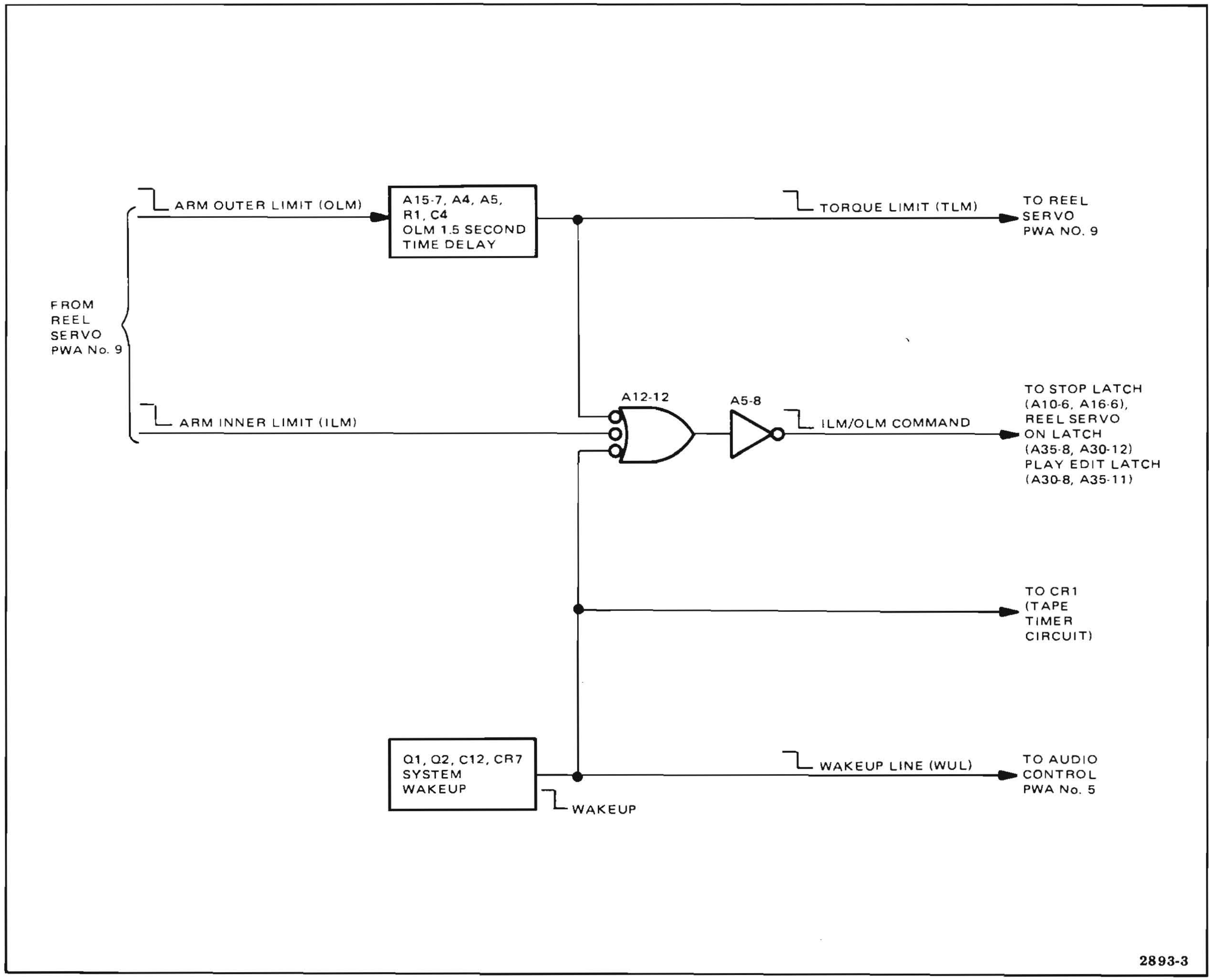



Figure 4-9. Transport Control PWA 7, Simplified Block Diagram (Sheet 3 of 3)

the heads as long as the EDIT pushbutton is held pressed. Pressing the EDIT pushbutton switch generates a low which disables gate A28-8. The high from A28-8 is inverted by A38-6 and a low tape lift command ($\overline{LFT}$) is routed to Reel Servo PWA 9.

If in fast forward or forward spool mode, and play mode is selected, the tape slows down to play speed (tape does not stop) and the tape lifter solenoid is de-energized (LFT logic low) when the tape reaches play speed. The tape lifter latch A22-8/A28-6 is reset, causing the tape lifter to retract (LFT logic low), by the following circuit action. The high from A11-8 (when not in a spool mode) of spool latch A11-11/A11-8 is applied to pin 13 of A7-11. When coming out of fast forward mode and the tape slows down to play speed, the capstan servo locks and the LKD command from the capstan servo goes low. This signal is inverted by A39-10 and enables gate A7-11. The low from A7-11 is inverted by A23-12 and triggers a 100-ms tape lifter delay circuit consisting of components A15-9/A22-3/A23-2/A22-11/R20/C25. The output of the delay circuit resets the tape lifter latch (pin 4 of A28-6).

To enter play mode from spool mode, the stop pushbutton is pressed followed by the immediate pressing of the play pushbutton. Except for the LKD (servo locked command) the circuit action is the same as described for fast forward to play mode. In spool mode, the capstan servo is phase locked (LKD logic low). When the stop pushbutton is pressed, the capstan servo does not immediately unlock. The 100-ms tape lifter delay circuit has the function of ignoring the LKD command until the servo can unlock when going from spool to stop. Without the time delay, the tape lifter would immediately retract when the stop pushbutton switch was pressed.

If stop mode is selected from any other mode and the tape is permitted to stop, the tape lifter latch is reset by the motion sense command (MTS) which goes high when the tape has stopped. This signal is inverted by A23-6 and resets the tape lifter tach (pin 3 of A28-6).

**4-39.** *Play Mode.* Pressing the play pushbutton switch causes play latch A7-3/A6-6 to set, and the low output at A6-6 is inverted by A34-8 and A38-4 to provide a logic low play command (PLC) that is routed to the Capstan Servo PWA 8.

**4-40.** *Record Mode.* Record mode is selected by simultaneously pressing the play and record pushbutton switches. Under this condition, gate A12-8 is enabled and sets record latch A18-3/A12-6. The high from A18-3 is applied to gate A18-6 which is enabled by the LKD signal from the capstan servo and signifies the capstan servo is locked.

The low from A18-6 sets secondary record latch A18-11/A18-8 and is also routed as a main record bus (MRB) command to Audio Control PWA 5 to enable the record signal electronics. The low output from A18-11 forces the forward direction (DRC) and play (PLC) commands to be generated. These signals are routed to the capstan servo. When record mode is established, a low electronic record status (ERS) signal from PWA 5 is received. This low is inverted by A39-6 and A39-12 and routed to the record indicator (RCI) to illuminate the indicator and signify that record mode has been established. When in record mode and the stop pushbutton switch is pressed, transport motion does not stop until the bias and erase signals applied to the record and erase heads, respectively, have decayed (ERS command goes high).

When the stop pushbutton switch is pressed, stop latch A10-6/A16-6 is set and record latch A18-3/A12-6 is reset. When the record latch resets, gate A18-6 is disabled (MRB goes high), which disables the record signal electronics control on PWA 5. A high from stop latch A10-6 is inverted by A17-12 and A7-6 and is applied to stop gate A35-6. After the bias signal has decayed, the ERS signal from PWA 5 goes high and resets the secondary record latch, and a high from A18-11 enables stop gate A35-6. When A35-6 is enabled, a logic low stop command (STC) is generated and routed to the capstan servo and reel servo PWA's to stop tape motion.

**4-41.** *Stop Record Mode.* If in record mode and the record pushbutton switch is held pressed while the stop pushbutton switch is momentarily pressed, the recorder will stop recording but the transport will continue to run. Tape motion stop is prevented by inhibiting gate A22-6 with a logic

low that is generated when the record pushbutton switch is pressed. The record latch is reset via gates A6-8 and A17-10 when the stop pushbutton switch is pressed.

**4-42.** *Thread Mode.* When power is initially applied and tape is threaded and taut so that either parallel connected microswitches S2 (supply) or S3 (takeup) are closed, pushing the stop pushbutton switch causes the reel servos to activate and place transport in a thread mode condition. Thread condition is indicated by the EDIT indicator light going off when the stop pushbutton is pressed.

Pressing the stop pushbutton switch causes one shot A24-6 to generate a 0.5-second logic low pulse which sets reel servo on latch A35-8/A30-12. The one-shot is used to assure ample time for the tension arms to move off the outer limit. The high from A35-8 is inverted by A39-2 to generate a logic low reel servo-on command (SVO), which is routed to Reel Servo PWA 9 to activate the reel servos. When the reel servo-on latch is set, the high from A35-8 is inverted by A30-6 and A39-4 and the EDIT indicator light goes out.

**4-43.** *Unthread (Stop/Edit) Mode.* If the tape is stopped, pressing the EDIT pushbutton switch causes the recorder to go into the unthread (same as stop/edit) mode. In this mode, the reel servos disengage. Pressing the EDIT pushbutton switch generates a logic low which is inverted by A23-10 which causes A28-12 to be enabled. The low from A28-12 resets reel servo latch A35-8/A30-12, which causes the reel servo on command (SVO) to be cancelled (SVO logic high). The low from A35-8 is inverted by A30-6 and A39-4 (EDI) to activate the EDIT indicator.

**4-44.** *Edit Modes.* If in play or record mode (capstan is phase locked) and the EDIT pushbutton switch is pressed, power will be removed from the takeup reel and the tension-arm roller will engage the capstan. This is called the play/edit mode.

Pressing the EDIT pushbutton switch generates a logic low, which is inverted by A23-10 and routed through a jumper in the E12/E13 position to enable gate A35-3 when the capstan servo is locked. The output from A35-3 sets play/edit latch A35-11/A30-8, and a low PEC (play/edit) command from A30-8 is routed to the reel servo. The low from A30-8 is inverted by A30-6 and A39-4 (EDI) to activate the EDIT indicator.

If in play/edit mode and the stop pushbutton is pressed, the tape will stop, edit mode will be retained, and tape can again be spilled by pressing the play pushbutton switch.

To cancel play/edit mode, the EDIT pushbutton switch is pressed when the tape is stopped. When the tape is stopped, the motion sense (MTS) line is high and the stop latch is set. Therefore, pressing the EDIT pushbutton switch enables A28-12. The low from A28-12 resets the play/edit latch and the servo-on latch which causes the recorder to enter the stop/edit (or unthread) mode. If desired to lock out the play/edit mode, the jumper may be placed in the E13/E14 play edit lock out position. This disables gate A35-3 and prevents the play/edit latch from being set.

If shuttle or spool mode is active, pressing the EDIT pushbutton switch causes the tape lifters to retract (solenoid de-energizes) and tape contacts the heads as long as the EDIT pushbutton switch is held pressed (see *Tape Lifter Operation* text).

When using the remove control unit to control recorder functions, the only edit function permitted is control of the tape lifters in shuttle or spool modes. The play/edit and stop/edit modes may not be activated from the remote control unit. On the remote control unit, the EDIT pushbutton switch is connected to Transport Control PWA 7 via the remote edit line (RED) rather than the edit button line (EDB).

**4-45. Tension Arm Limit Detectors.** During recorder operation, if a condition exists where the tension arms should move in too far toward the head assembly or too far out toward the reels, a logic low ILM (inner limit) or OLM (outer limit) command is generated on the Reel Servo PWA 9 and routed to the Transport Control PWA 7. The ILM command causes the recorder to immediately enter the stop/edit (unthread) mode and the OLM command causes the recorder to enter the stop/edit mode after an approximate 1.5-second time delay.

The ILM command is inverted by A12-12 and A5-8 and sets the stop latch and resets reel servo on latch and the play/edit latch. The OLM command is applied to a time delay circuit consisting of 1.5-second one-shot A15-7 and components A4-3/A5-4/A4-6/R1/C4. If the OLM command is low for more than 1.5 seconds, the recorder will enter the stop/edit mode as described for the ILM command.

During the start of thread mode, the OLM command is low and the delayed OLM command from A4-6 is routed as a torque limit command (TLM) to Reel Servo PWA 9 to limit the unwinding reel torque during the start of thread mode.

**4-46. Audio Control PWA 5**

The Audio Control PWA 5 performs the following functions:

1. Accepts mode and channel selection commands from the control unit and performs combinational logic functions to establish desired mode of operation.
2. Generates a master frequency of 5.1840 MHz which is divided down and used to provide reference frequencies for the capstan and reel servos, bias and erase amplifiers, and clock frequencies for the tape timer and multiplexer.
3. Conditions master bias bus signals and erase bus signals for distribution to the audio PWA's.

The functions performed by PWA 5 are shown on simplified block diagrams. For complete circuit information, refer to PWA 5 Schematic Diagram 4840398.

**4-47. Signal Mode Selection.** Figure 4-10 is a simplified interconnection block diagram of the signal mode selection circuits and Figure 4-11 is a simplified block diagram of the signal mode selection circuits for channel 1. Figure 4-11 shows the relationship and functions of the various circuits that operate to establish a recorder/reproducer signal mode of operation and associated signal mode monitoring. The desired signal mode and channel(s) are selected by pressing pushbutton switches on the recorder control unit. These command signals are routed to Audio Control PWA 5 to program the desired mode of operation. PWA 5 contains four separate mode select circuits, one for each channel. Since each circuit operates identically, only channel 1 is described in detail.

There are four channel-select lines (channels 1-4) and five function-select lines (ready, safe, sync, repro, and input). Pressing the associated pushbutton switch generates a logic low command which is routed to PWA 5. These momentary command signals are stored in latch circuits and processed by combinational logic to provide four two-state logic commands which are routed to Main Audio PWA 1 (for channel 1). Output signals for some of the various functions are summarized in Table 4-5.

**4-48.** *Latches.* The momentary commands, generated when a channel select and a function select pushbutton switch are simultaneously pressed, cause the command to be stored in a latch. Each of these latch circuits has one output, but some have more than one set or reset input to provide various modes of operation as determined by the combinational state of the latches. The following latches are associated with channel 1 operation.

**4-49.** *Ready/Safe Latch.* The ready/safe latch A9-7 is set by a ready command and reset by a safe command.

**4-50.** *Sync/Rep Latch.* The sync reproduce latch A9-13 is set by a sync command and reset by a reproduce command.

**4-51.** *Tape/Input Latch.* The tape/input latch A9-4 is set by either a reproduce or sync command and is reset by an input command.

**4-52.** *Safe/Record Latch.* The safe/record latch A9-9 is set (to safe) by any one of the following commands: main record bus (MRB), wakeup line (WUL), safe command, or ready command. The latch is reset when the following three conditions are present: ready/safe latch is in the ready (set) state, main record bus (MRB) is active, and play and record (PDR) command is active.

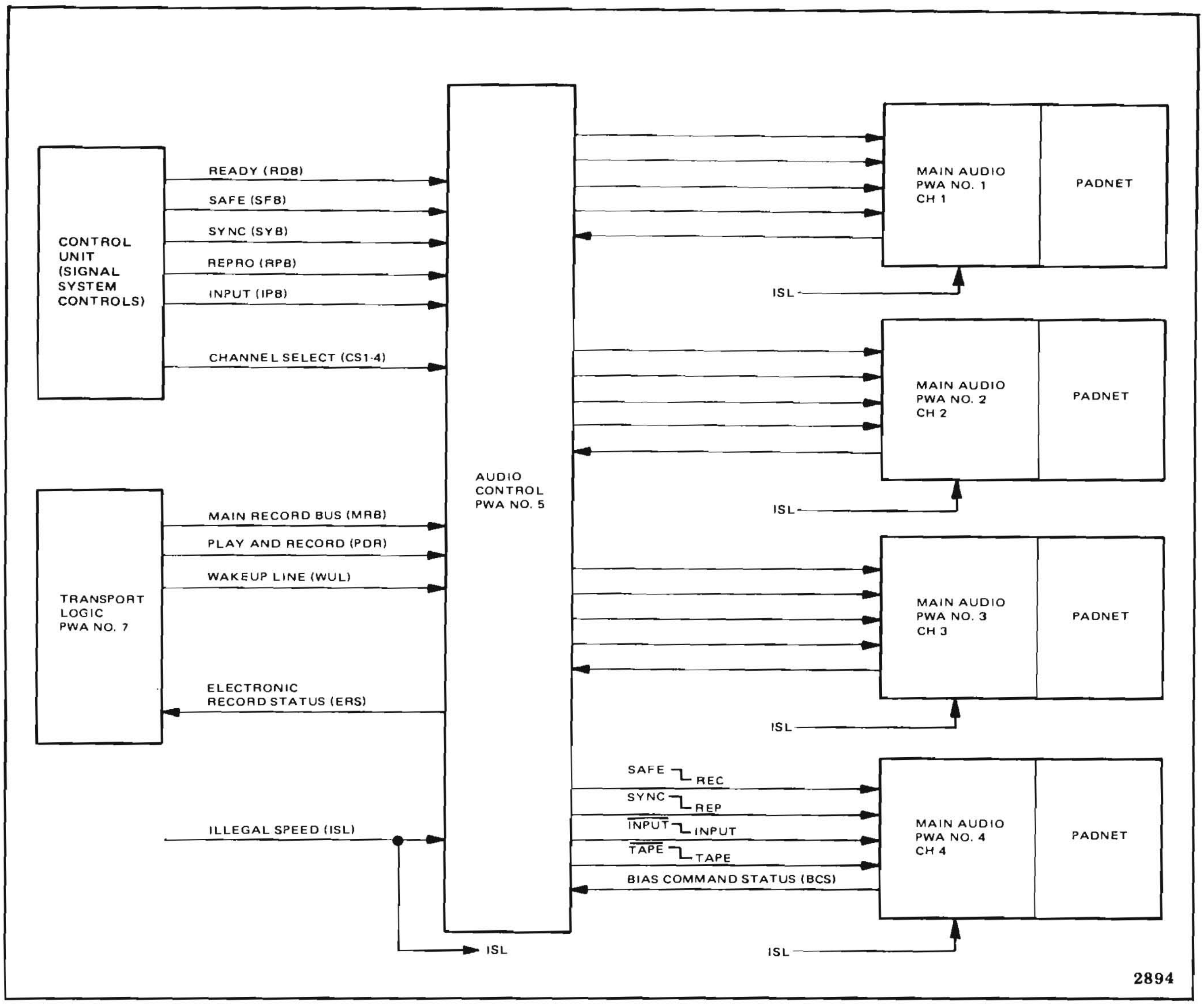



**Figure 4-10. Signal Mode Selection, Interconnection Simplified Block Diagram**

**4-53.** *Safe Mode.* In safe mode, the channel is prevented from entering record mode. Simultaneously pressing SAFE and channel 1 pushbutton switches enables gate A10-8. The low from A10-8 resets ready/safe latch A9-7 to the safe state. The low from A10-8 is also inverted by A8-6 and A6-8 and sets safe/record latch A9-9 to the safe state. The high from A9-9 is buffered by A5-8 and routed to PWA 1 to place the audio electronics in a safe (record mode inhibited) condition. The low from A9-7 inhibits record interlock gate A8-8. This prevents the safe/record latch A9-9 from being reset to the record state if the play and record pushbuttons are simultaneously pressed to place other channels in the record mode. The low from A9-7 is also routed to the multiplexer (paragraph 4-61) to cause the SAFE indicator to illuminate.

**4-54.** *Ready Mode.* A channel in ready mode can enter record mode. Simultaneously pressing READY and channel 1 pushbutton switches enables gate A10-6. The low from A10-6 causes ready/safe latch A9-7 to set, and the high from

A9-7 is applied as one input to three-input record-interlock gate A8-8 to establish conditions for entering record mode (described later). The low from A10-6 is also applied to the multiplexer to cause the channel 1 READY indicator to illuminate. The low from A10-6 is also inverted by A8-6 and A8-8 to set safe/record latch A9-9 to the safe position for the same purpose as described for safe mode. That is, it enables the safe/record latch A9-9 to be temporarily placed in the safe mode with ready/safe latch A9-7 left in ready mode.

**4-55.** *Record Mode.* To enter record mode, the channel must be in ready mode and the PDR (play and record) and MRB (main record bus) lines active (logic low). When the play and record pushbuttons are simultaneously pressed, the PDR line becomes active and triggers 900-ms one-shot A32-6. The high from A32-6 is applied as a second input to A8-8. Approximately 150 to 500 ms (up to 500 ms if tape is stationary) after the two pushbuttons are pressed, the MRB line becomes active, indicating the capstan servo has locked. The MRB logic low is inverted by A40-6, A8-8, and resets safe/record latch A9-9 to the record position. The low from A9-9 is buffered by A5-8 and routed to Main Audio PWA 1 to place the audio electronics in the record mode. Immediately prior to the bias signal runup to maximum level, a low BCS (bias command status) command from PWA 1 enters PWA 5 and is inverted by A6-2, A6-4, A34-6 and A27-6 and routed to transport control PWA 7 as a low ERS (electronic record status) command signal. This signal causes the master record indicator to illuminate. Also the low BCS command at the junction of A6-4 and pin 5 of A34-6 is routed to the multiplexer to cause the channel 1 record indicator to illuminate. The illumination of the master record and the channel 1 record indicators is a positive indication that the record process has occurred on PWA 1.

If an MRB signal is not received within the 900-ms window established by one-shot A32-6, gate A8-8 is inhibited and the system does not enter record mode. One-shot A32-8 is reset when the MRB signal arrives. The output from the one-shot and the inverted MRB signal are applied to gate A40-3. The gate is enabled by the MRB signal and the output from A40-3 resets one-shot A32-6. The width of the pulse applied to pin 10 of safe/record latch A9-9 is approximately 300 ns long and is equal to the propagation delay through A40-3 and A32-6 plus the time delay caused by R35 and C18, which are used to widen the width of the pulse applied to the clear input of A32-6.

When in record mode and the stop pushbutton is pressed, the transport does not stop until the bias and erase signals have decayed. When the stop pushbutton switch is pressed, MRB goes high and causes the safe/record latch A9-9 to be set to the safe position. The high from A9-9 is buffered by A5-8 and routed to PWA 1 to place the signal electronics in the safe mode. After the bias and erase signals have decayed, the BCS command goes high causing the ERS command to go high. The high ERS command is routed to Transport Control PWA 7 to reset the secondary record latch which causes the transport to come to a stop.

If in record mode and the ready and channel 1 pushbutton switches are simultaneously pressed, the channel 1 signal electronics will revert to safe but the transport will continue to run. Pressing the two pushbuttons causes safe/record latch A9-9 to be set to the safe position. The high from A9-9 is buffered by A5-8 and routed to PWA 1 to place channel 1 signal electronics in the safe mode. Since the ready/safe latch A9-7 is still in the ready state, channel 1 may be returned to record mode by simultaneously pressing the play and record pushbutton switches. When these pushbuttons are pressed, the safe/record latch A9-9 is reset to the record state.

If in record mode and the safe and channel 1 pushbutton switches are simultaneously pressed, channel 1 signal electronics will revert to safe but the transport will continue to run. Pressing the two pushbuttons causes the ready/safe latch A9-7 to be reset to safe and the safe/record latch A9-9 to be set to safe. To re-enter record mode, channel 1 must be reset to the ready state.

**4-56.** *Reproduce Mode.* In reproduce mode, the signal being reproduced by the reproduce head is connected to the audio output. Simultaneously pressing REPRO and channel 1 pushbutton switches enables gate A10-3 which resets sync/reproduce latch A9-13 to the reproduce state. The

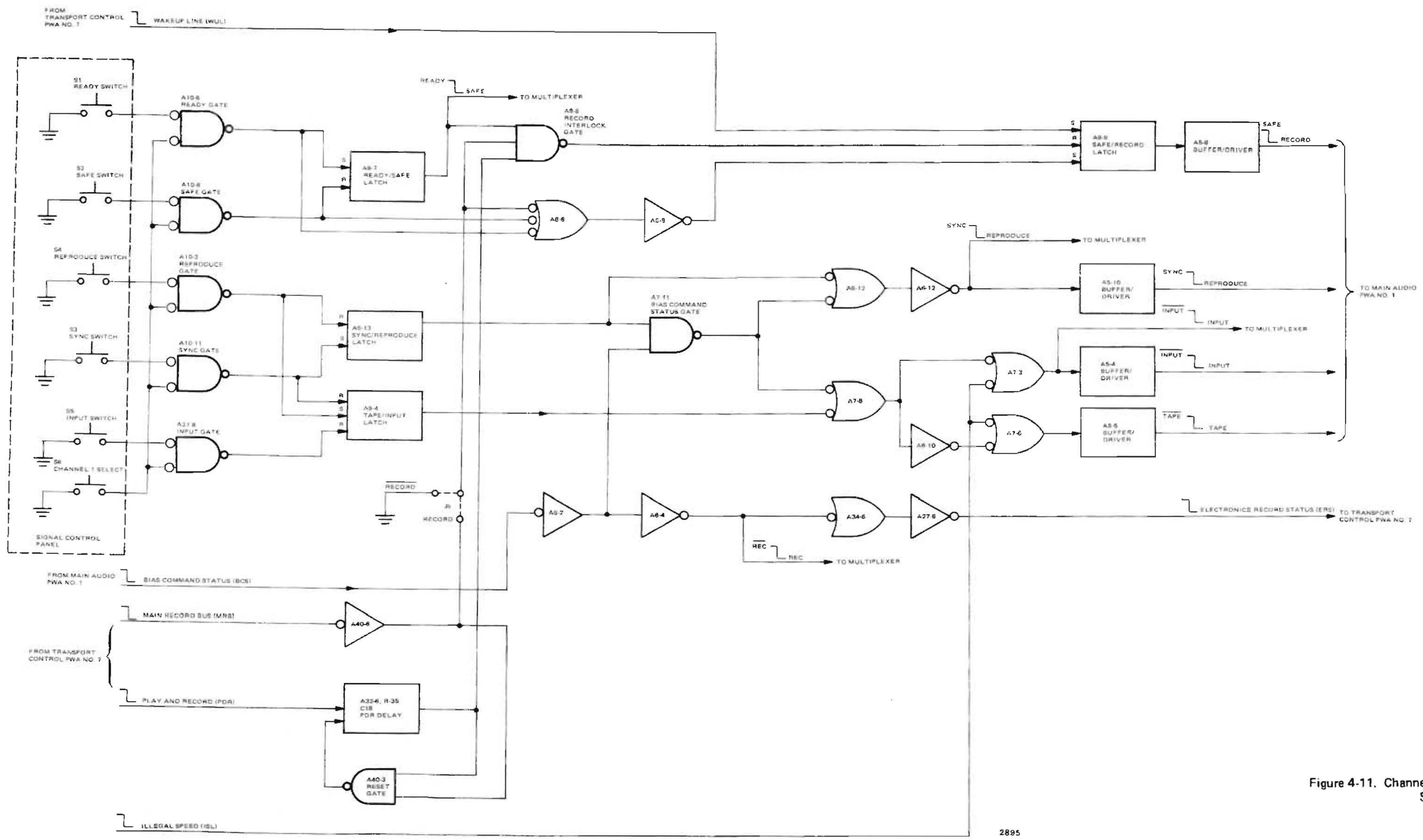



Figure 4-11. Channel 1 Signal-Mode Selection Simplified Block Diagram, Audio Control PWA 5

Table 4-5. Channel 1 Signal Mode Selection Output-Signal Logic States

| FUNCTIONS | OUTPUT SIGNAL LOGIC STATE | | | |
|---|---|---|---|---|
| | $\overline{\text{SAFE}}$/RECORD (PIN 24) | $\overline{\text{SYNC}}$/REP (PIN 23) | $\overline{\text{INPUT}}$/INPUT (PIN R) | $\overline{\text{TAPE}}$/TAPE (PIN 14) |
| INPUT | X | X | L | H |
| REPRODUCE | H | L | H | L |
| SAFE | H | X | X | X |
| READY | H | X | X | X |
| RECORD | L | L | X | X |
| SYNC AND READY OR SAFE | H | H | H | L |
| RECORD FROM SYNC MODE | L | L | L | H |

L = low
H = high
X = low or high depending on combination of modes selected

low from A9-13 is inverted by A8-12 and A6-12, buffered by A5-10 and routed to PWA 1 as a low reproduce (rep) command. Also the low at the output of A6-12 is routed to the multiplexer to cause the REPRO indicator to light.

Pressing the two pushbutton switches also causes the tape/input latch A9-4 to set to the tape state. Under this condition, the $\overline{\text{input}}$/input line is high ($\overline{\text{input}}$), and the $\overline{\text{tape}}$/tape is low (tape). Both of these commands are routed to PWA 1 to cause the tape signal to be monitored.

**4-57.** *Sync Mode.* In sync mode, the signal on tape is reproduced by the record head. Simultaneously pressing SYNC and channel 1 pushbutton switches enables gate A10-11 which sets sync/reproduce latch A9-13 to the sync state. This permits A8-12 to be low and this signal is inverted by A6-12, buffered by A5-10, and routed to PWA 1 as a high sync command. The high from A6-12 is routed to the multiplexer to cause the SYNC indicator to light.

Pressing the two pushbutton switches also causes the tape/input latch A9-4 to set to the tape state. As in reproduce mode, the $\overline{\text{input}}$/input line is high ($\overline{\text{input}}$), and the $\overline{\text{tape}}$/tape line is low (tape).

If a channel is in sync mode and that same channel is placed into record mode (channel is in ready and the play and record pushbuttons are simultaneously pressed), the logic circuitry on PWA 5 will automatically switch the monitoring circuitry on PWA 1 from the record head to the input signal. Pressing the play and record pushbutton switches causes the BCS signal entering PWA 5 to become active (low). (See *Record Mode* description.) This signal is inverted by A6-2 and enables A7-11. The low from A7-11 is inverted by A8-12 and A6-12, buffered by A5-10, and routed to PWA 1 as a low (rep) command. This disconnects the sync preamplifier from the equalizer amplifier and connects the reproduce head to the equalizer amplifier. The low from A7-11 causes the $\overline{\text{input}}$/input line to be low (input) and the $\overline{\text{tape}}$/tape line to be high ($\overline{\text{tape}}$). This enables the input to be monitored. The low from A7-3 is routed to the multiplexer to cause the INPUT indicator to light.

**4-58.** *Input Mode.* When input monitoring mode is selected, the input signal to the recorder is connected to the audio output for monitoring

Table 4-5. Channel 1 Signal Mode Selection Output-Signal Logic States

| FUNCTIONS | OUTPUT SIGNAL LOGIC STATE | | | |
|---|---|---|---|---|
| | SAFE/RECORD (PIN 24) | SYNC/REP (PIN 23) | $\overline{\text{INPUT}}$/INPUT (PIN R) | $\overline{\text{TAPE}}$/TAPE (PIN 14) |
| INPUT | X | X | L | H |
| REPRODUCE | H | L | H | L |
| SAFE | H | X | X | X |
| READY | H | X | X | X |
| RECORD | L | L | X | X |
| SYNC AND READY OR SAFE | H | H | H | L |
| RECORD FROM SYNC MODE | L | L | L | H |

L = low
H = high
X = low or high depending on combination of modes selected

low from A9-13 is inverted by A8-12 and A6-12, buffered by A5-10 and routed to PWA 1 as a low reproduce (rep) command. Also the low at the output of A6-12 is routed to the multiplexer to cause the REPRO indicator to light.

Pressing the two pushbutton switches also causes the tape/input latch A9-4 to set to the tape state. Under this condition, the $\overline{\text{input}}$/input line is high ($\overline{\text{input}}$), and the $\overline{\text{tape}}$/tape is low (tape). Both of these commands are routed to PWA 1 to cause the tape signal to be monitored.

4-57. *Sync Mode.* In sync mode, the signal on tape is reproduced by the record head. Simultaneously pressing SYNC and channel 1 pushbutton switches enables gate A10-11 which sets sync/reproduce latch A9-13 to the sync state. This permits A8-12 to be low and this signal is inverted by A6-12, buffered by A5-10, and routed to PWA 1 as a high sync command. The high from A6-12 is routed to the multiplexer to cause the SYNC indicator to light.

Pressing the two pushbutton switches also causes the tape/input latch A9-4 to set to the tape state. As in reproduce mode, the $\overline{\text{input}}$/input line is high ($\overline{\text{input}}$), and the $\overline{\text{tape}}$/tape line is low (tape).

If a channel is in sync mode and that same channel is placed into record mode (channel is in ready and the play and record pushbuttons are simultaneously pressed), the logic circuitry on PWA 5 will automatically switch the monitoring circuitry on PWA 1 from the record head to the input signal. Pressing the play and record pushbutton switches causes the BCS signal entering PWA 5 to become active (low). (See *Record Mode* description.) This signal is inverted by A6-2 and enables A7-11. The low from A7-11 is inverted by A8-12 and A6-12, buffered by A5-10, and routed to PWA 1 as a low (rep) command. This disconnects the sync preamplifier from the equalizer amplifier and connects the reproduce head to the equalizer amplifier. The low from A7-11 causes the $\overline{\text{input}}$/input line to be low (input) and the $\overline{\text{tape}}$/tape line to be high ($\overline{\text{tape}}$). This enables the input to be monitored. The low from A7-3 is routed to the multiplexer to cause the INPUT indicator to light.

4-58. *Input Mode.* When input monitoring mode is selected, the input signal to the recorder is connected to the audio output for monitoring

purposes. Simultaneously pressing the INPUT and channel 1 pushbutton switches enables gate A37-8, which resets tape/input latch A9-4 to the input state. The low at A7-3 is routed to the multiplexer to cause the INPUT indicator to light.

**4-59. Wakeup Line.** When power is first applied to the recorder, the system wakeup circuit (located on Transport Logic PWA 7) causes the recorder to enter stop/edit mode; tape timer to indicate 0 00 00; SAFE, REPRO, stop, and EDIT indicators to light; and audio channels to enter safe and reproduce modes. When power is first applied, the wakeup line (WUL) becomes active (low) for five seconds. This low is applied to gate A40-11 to inhibit the master bias bus (paragraph 4-64), and the low is also applied through buffer A38 to each of the four channel-select lines and to the safe and reproduce function-select lines. This causes the sync/reproduce latch A9-13 to be in the reproduce state (A9-13 low) and the safe/record latch A9-9 to be in the safe state (A9-9 high). In the event that PWA 7 is not installed and power is applied, capacitor C11 will charge through R21 and temporarily apply a low through CR6 to A38 to substitute for the WUL logic low command.

**4-60. Illegal Speed.** If a speed is selected for which the audio channels have not been set up (and/or speed and bias jumper positions on audio control PWA 5 are incorrect), play and record modes of operation at that speed are locked out of operation. If an illegal speed is selected, the illegal speed line (ISL) becomes active (low). This low is inverted by A7-3 and A7-6 to cause the $\overline{\text{input}}$/input and $\overline{\text{tape}}$/tape lines to both go high. This causes the audio output from all audio PWA's (PWA's 1, 2, 3, and 4) to be muted.

**4-61. Multiplexer System.** The multiplexer system accepts mode and channel status information and causes the appropriate LED indicators to be illuminated on the control unit. Figure 4-12 is a simplified interconnection block diagram of the multiplexer system circuitry.

The multiplexer system accepts channel and mode select data from the signal mode selection logic circuitry (paragraph 4-47) and sequentially loads this data in parallel form in two shift registers located on PWA 5. This data is shifted out in serial form on a single line to six series-connected shift registers located on the local control unit (and remote control unit if used). The shifted data is used to illuminate the appropriate LED indicator (SYNC, REPRO, INPUT, SAFE, READY and Record). A slow clock rate (4.8 kHz) and a fast clock rate (144 kHz) are alternately used in the multiplexer system circuitry to enable the LED indicators to be illuminated continuously 97% of the time.

Figure 4-13 is a simplified block diagram of the multiplexer system circuitry on PWA 5. Recall that each of the four channel and mode selection logic circuits provide four two-state logic commands. These commands are $\overline{\text{rec}}$/rec, ready/safe, tape/input and sync/rep. Since there are four audio channels, 16 lines of data (4 X 4) are supplied to the input of two multiplexer devices (A35 and A36). Each multiplexer (A35 and A36) is a dual 4-line-to-1-line data selector and in operation, the combination is synonymous to a 4-pole 4-way switch.

These four logic-state inputs to the multiplexers from each channel are selected in sequence (channel 1, channel 2, etc.). This input signal selection is controlled by a 2-bit binary coded signal (binary 0-3 count) applied to the select A and select B inputs of the multiplexer devices. (The source of this binary signal is described later.) The strobe (enable) input to each multiplexer is hard-wired low and therefore the multiplexers are continuously enabled.

The four selected signals from the output of the two multiplexers are applied to four NAND gates (A42-3, -6, -8, and -11) that perform combinational logic to provide six signals. These six signals are applied to the parallel inputs of shift registers A33 and A41, and each signal corresponds to an LED indicator on the control unit (SYNC, REPRO, INPUT, SAFE, READY, and Record). A low state of the input signal signifies that the associated LED indicator is to be illuminated.

In addition to the six data line inputs from the combinational logic, there are three hard-wired inputs applied to shift register A33. Input A and the serial input are hard-wired high (+5 Vdc) and input B is hard-wired low (ground). These inputs

are used to identify when a frame of data has been shifted through the shift registers.

When the mode control input signal (described later) applied to the shift registers goes high, the input data and the high on input A and the low on input B are loaded into the shift registers on the next high-to-low transition of the input clock pulse. During this parallel load sequence, the entry of serial data is inhibited (this is accomplished internally in the shift registers by the high mode-control signal). The loading of data causes the mode control to go low, which permits the data to be shifted serially. The next six clock pulses cause the channel data to be serially shifted through the shift registers and sent in serial form (from pin 10 of A41) to the first six cells of six series-connected serially-loaded shift registers located on the control unit.

As the data is shifted (direction A toward D), the hard-wired high applied to the serial input of A33 is also shifted until there are four adjacent high outputs from the shift register preceded by the hard-wired low. After a frame of data six bits long has been shifted through the shift register, the four adjacent highs enable gate A34-8 which serves as a channel frame detector. (Note that the data input can never be four adjacent highs.)

When A34-8 is enabled, the low from A34-8 is inverted by A2-8 and is applied as a high to the mode control input of the shift registers. This changes the shift register mode of operation from serial shift to parallel load and enables the shift registers to load the next set of data (channel 1) from the multiplexers when the binary-coded select A and select B lines change state.

At the end of a frame of data, the low from A34-8 is also used to clock a binary counter, formed by A4-12 and A25-8, to its next state to enable the multiplexers to select data from the next channel (channel 2). The output from divider A4-12 and A25-8 is supplied to the select A and B inputs of the multiplexers.

In addition, the low from A34-8 is applied to gate A26-11 which inhibits the fast rate clock from divider A4-8 (through gate A26-6) during parallel load time. When A34-8 is high, the fast rate clock is routed to the control unit to clock the six series-connected shift registers. (Note: Only the fast rate clock is routed to the control unit.) After the data from all four channels has been shifted into the six shift registers on the control unit, the multiplexers and shift registers on PWA 5 repeat the four-channel sequence but are controlled by the slow rate clock. Also during this slow rate clock sequence, the gated clock signal normally supplied to the six series-connected shift registers on the control unit is held high (inhibited by a low from A25 pin 6) to prevent the data from being entered during the slow clock sequence. As the ratio of the clock signals (4.8 kHz and 144 kHz) is 30:1, the LED indicators are continuously illuminated 97% (duty cycle) of the time.

As previously stated, the 144-kHz clock and 4.8-kHz clock are alternately used for each four-channel sequence. The output from frame detector A34-8 is divided by A4-12 and A25-8 and fed to D flip-flop A25-5 which provides complementary outputs. These outputs are used to alternately enable gates A26-3 and A26-6, which enable the 4.8 kHz clock and the 144 kHz clock, respectively. The selected clock is inverted by A26-8 and applied to one-shot A32-10 which provides a clean fixed-width pulse used to clock shift registers A33 and A41. The clock-pulse edge used to clock A33 and A41 occurs earlier than the clock edge used to clock the shift registers in the control unit. This permits the data input to the control unit to settle before being strobed.

**4-62. Master Oscillator and Counters.** The master oscillator generates a frequency of 5.184 MHz which is divided down and used for the following functions: reference frequencies for the capstan servo, switching carrier for the reel servo, audio bias and erase frequencies, and clock frequencies for the multiplexer system circuitry and the tape timer. Figure 4-14 is a simplified block diagram of the master oscillator and counters.

The master oscillator consists of a non-inverting amplifier with positive feedback provided by a crystal resonating at the desired frequency. The non-inverting amplifier consists of inverters A2-2 and A2-4 connected in cascade. Inverter A2-2 serves as a quasi-linear amplifier with inversion between its input and output terminals.

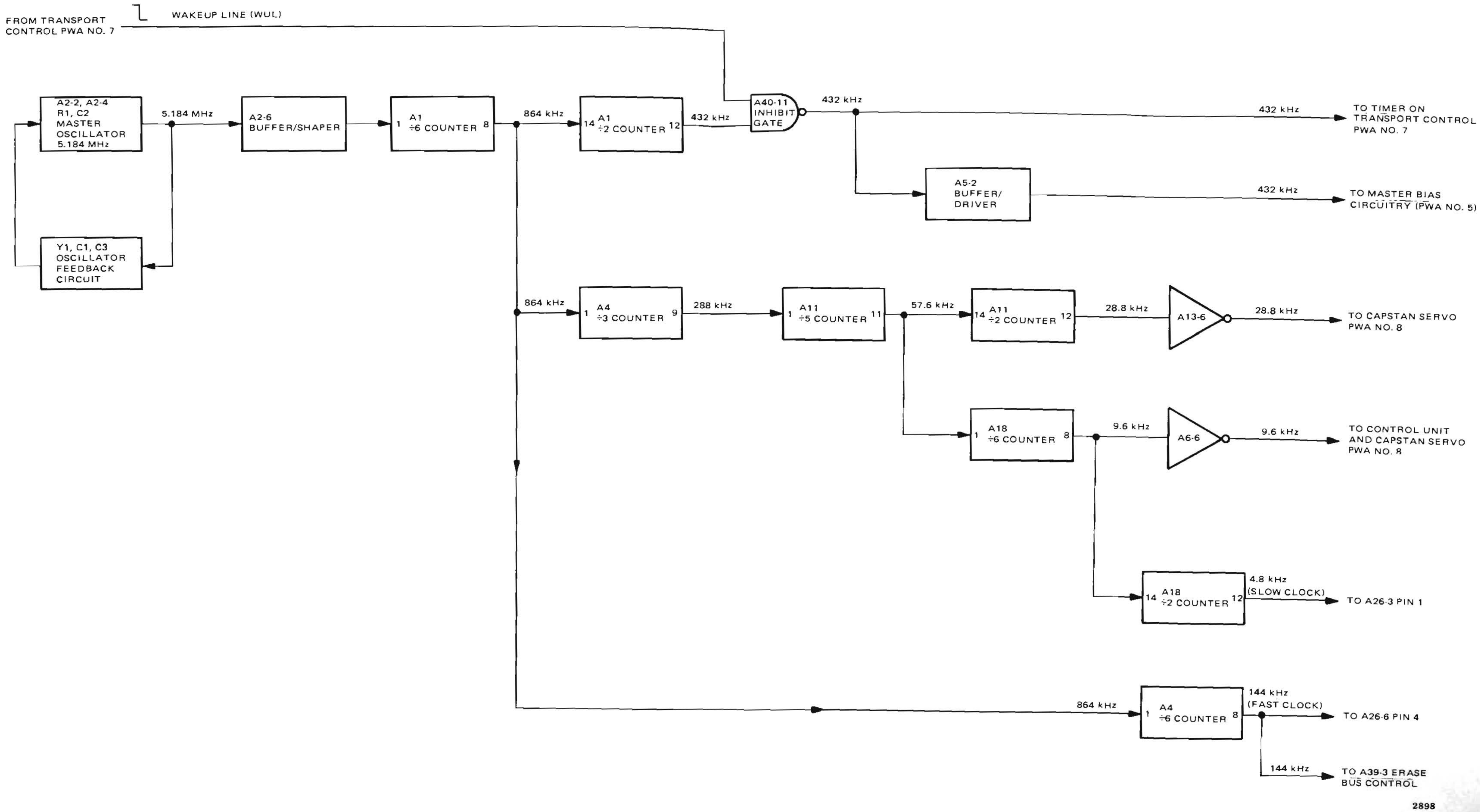



Figure 4-14. Master Oscillator and Counters, Simplified Block Diagram (PWA 5)

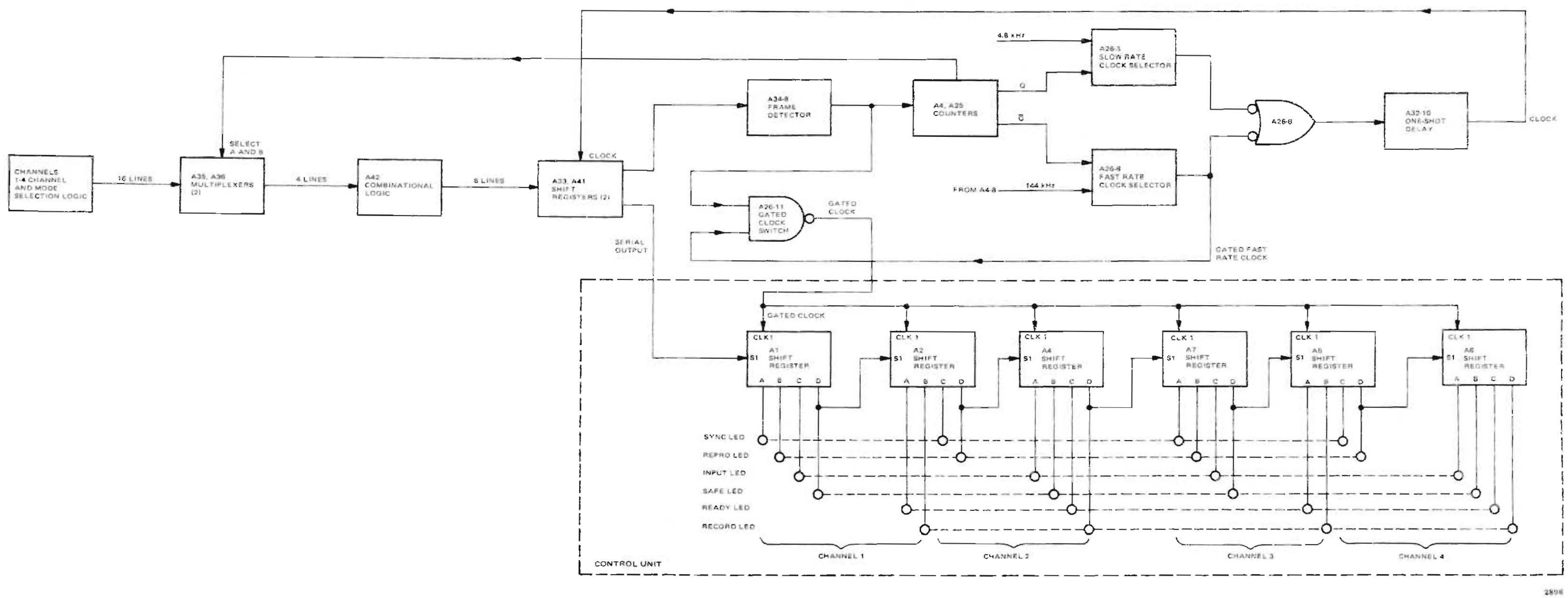



Figure 4-12. Multiplexer Simplified Interconnect Block Diagram, Audio Control PWA 5 and Control Unit

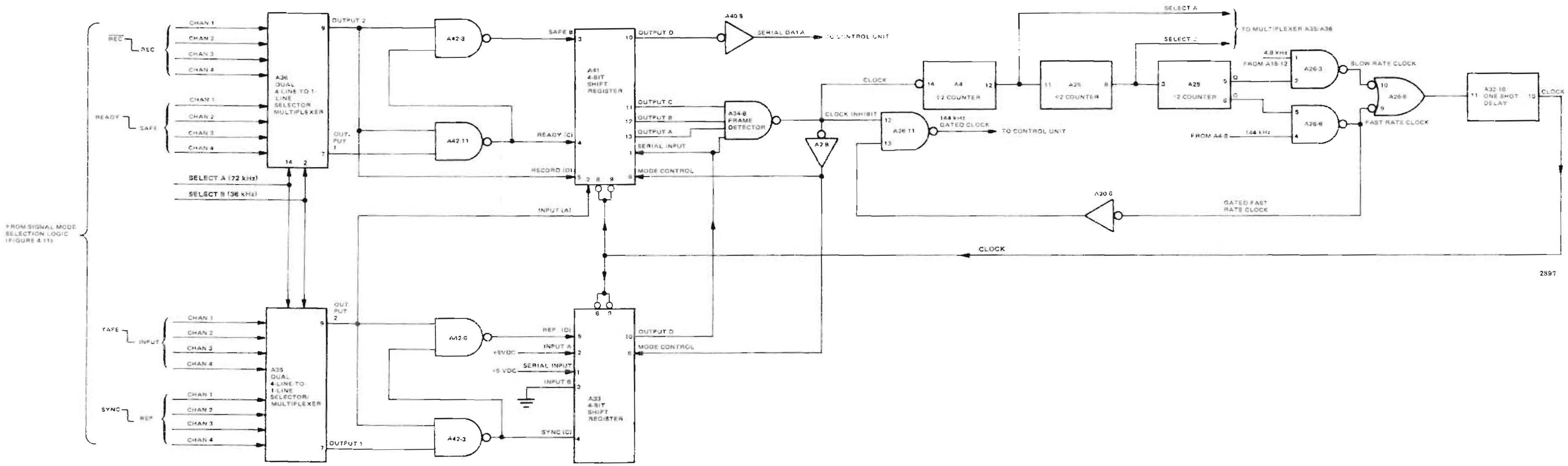



Figure 4-13. Multiplexer Simplified Block Diagram, Audio Control PWA 5

Resistor R1, in parallel with inverter A2-2, provides negative feedback and causes the inverter to try to operate as a linear amplifier. Any small disturbance at the input of A2-2 appears as an in-phase transition at the output of A2-4. This signal is applied to divider C1/C3, and the signal at the junction of C1 and C3 is fed back to the input of the amplifier through crystal Y1. Crystal Y1 acts as a very-high-Q tuned series-resonant circuit that passes only the desired frequency of 5.184 MHz. Capacitor C2 bypasses undesired harmonics and inverter A2-6 buffers the 4.184-MHz signal to provide a clean square-wave signal that is applied to the divider chain.

The 5.184-MHz signal is divided down by counters A1-8, A1-12, A4-8, A4-9, A5-2, A11-11, A11-12, A18-8, and A18-12 to provide the various signals shown on simplified block diagram Figure 4-14.

**4-63. Master Erase Bus.** The master erase bus circuitry accepts the 144-kHz TTL level signal from the master-oscillator counter and buffers the signal, lengthens the rise time, and provides an adjustable erase signal level that can be verified between the limits of 0 to 12 volts p-p.

As shown in Figure 4-15, the 144-kHz TTL level signal from counter A4-8 is fed through R33 to inverting CMOS amplifier A39-5/1. This amplifier serves as a buffer and ground translator which transfers the 144-kHz TTL level signal from logic ground to the audio system ground. The amplifier provides an output signal that swings between the limits of 0 and +5 Vdc. This output signal is applied across the master erase bus level control R34 which is used to establish the erase bus signal level applied to the main audio PWA's.

In the event that the 15-Vdc operating voltage, applied to the CMOS device A39, should be removed while an input signal is present, R33 will limit the input current and prevent the device from being damaged.

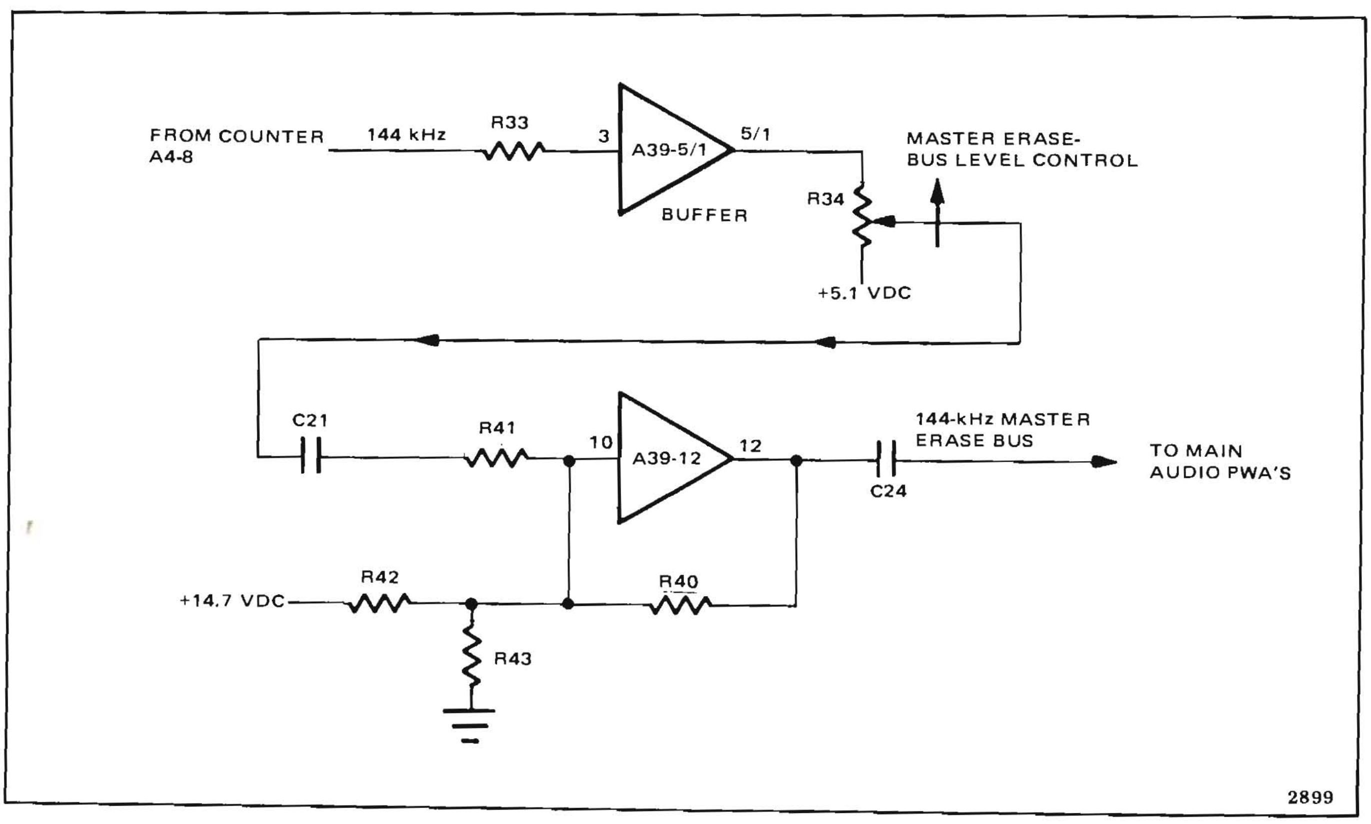



Figure 4-15. Master Erase Bus, Simplified Schematic Diagram, Audio Control PWA 5

The signal level selected by R34 is ac-coupled through C21 and through R41 to inverting amplifier A39-12 with feedback provided by R40. This amplifier has a gain of 3 and also serves to reduce the signal rise time which minimizes radiation into adjacent circuitry. The input of the amplifier is biased to a 7.5-Vdc level by voltage divider R42 and R43, which causes the output to be at a 7.5-Vdc nominal level and the amplifier to operate in the center of its linear range. The output signal level at pin 12 of A39 can be varied from 0 to 12 volts p-p by adjustment of master erase bus level control R34. This signal is ac-coupled through C21 and routed to Main Audio PWA's 1, 2, 3, and 4.

**4-64. Master Bias Bus.** The master bias bus circuitry accepts the 432-kHz TTL level signal from the master oscillator counter and buffers the signal, reduces the rise time, and provides four adjustable bias signal levels that are individually selected by a speed select logic circuit.

As shown in Figure 4-16, the 432-kHz TTL level signal from counter A1-12 is buffered and referenced to audio ground by open collector buffer/driver A5-2. The signal is applied to the junction of a voltage divider consisting of R54 and the bias level adjustment controls R3 through R6.

The other end of the adjustment controls are connected (through switch S1 and a jumper array) to the output of a 1-out-of-4 decoder speed-select logic circuit consisting of quad NAND gate A3 and inverters A2-10 and A2-12. The speed select A and B signal (SSA and SSB) in the form of a 2-bit binary encoded signal from the transport speed select switch is applied to the input of the decoder. Depending on the speed selected, one of the NAND gates (A3) is enabled, and provides a ground return (low) for one of the bias level adjustment controls. Jumper plugs J1 through J4 are used to program the recorder for 2- or 4-speed operation as shown in Table 4-6.

**4-65.** *Two-Speed Operation.* The simplified schematic (Figure 4-16) shows jumper plug connections for two-speed (7.5 and 15 in/s) operation. Switch S1 provides operational flexibility by permitting selection of either of two preset bias levels for each speed. Switch S1 in the Equalization I position enables potentiometers R4 and R6, and the switch in the Equalization II position enables potentiometers R3 and R5 when the associated speed is selected.

Depending on the speed selected, the associated bias level adjustment control is adjusted to the desired 432-kHz signal level, and this level is ac-coupled through C22 and through R39 to inverting amplifier A39-3/8 with feedback provided by R55. The amplifier has a gain of approximately 2, and reduces the signal rise time to minimize radiation into adjacent circuitry. The input to the amplifier is biased to a 7.5-Vdc level by voltage divider R39 and R37 which causes the output signal to be at a 7.5-Vdc nominal level and the amplifier to operate in the center of its linear range. The output signal level at pin 13/8 of A39 can be varied from 0 to 8.0 volts p-p by adjustment of a bias level adjustment control. The output signal is ac-coupled through C25 and routed to Main Audio PWA's 1, 2, 3, and 4.

**4-66.** *Four-Speed Operation.* For four-speed operation, jumper plugs J1 through J4 are positioned as shown in Table 4-6. Note that for four-speed operation, switch S1 should remain in the "I" position, as one bias level adjustment control is used for each speed, as shown in the table.

**4-67. Illegal Speed Detector.** If jumpers J1 through J4 are positioned for two-speed operation (Table 4-6) and one of the other non-programmed speeds is selected by operation of the transport speed select switch, the illegal speed line (ISL) will become active (low) and cause the transport to become inactive in play and record modes at that speed. (The ISL line also becomes active if no jumpers are installed.)

The illegal speed detector circuitry consists of diodes CR1 through CR5, capacitor C5, and transistor Q1. When a speed is selected for which jumpers J1 through J4 have been correctly placed, one diode (CR1 through CR4) will conduct and its anode will be one diode drop (0.7 volt) above the saturated output of A3. This prevents Q1 from turning on and generating an ISL command because of the voltage drop across CR5.

If an incorrect speed is selected, one or more of diodes CR1 through CR4 will open-circuit and

diode CR5 will conduct and charge C5. After C5 is charged, Q1 will turn on and generate a low ISL command. In addition to causing the transport to become inoperative, the low from the collector of Q1 also causes the $\overline{\text{input}}$/input and $\overline{\text{tape}}$/tape output lines to both become high. This causes the audio output lines from each Audio PWA to become muted.

### 4-68. Main Audio Functional Description

The main audio consists of up to four identical main audio PWA's and their parameter-determining network (PADNET) PWA's. One main audio PWA and its associated PADNET PWA comprise the main audio for each record/reproduce channel. The main audio for channels 1 through 4 is located on PWA 1 through PWA 4, respectively. The Main Audio PWA and its associated PADNET PWA contain the erase, record, reproduce, and audio output circuits for one audio channel. Additionally, control logic circuitry located on the main audio board and PADNET provides bias and erase ramping control, pick-up record capability (PURC), tape-speed decoding, and other timing and control signals required by the main audio for that channel. The speed-dependent record and reproduce equalization networks, record and reproduce level presets, bias normalization preset, and tape-speed decoding logic are contained on the PADNET assembly which plugs into the main audio board. The PADNET is capable of being adjusted to provide for record and reproduce equalization and can accommodate all equalization standards at any one of the selected transport tape speeds (30, 15, 7.5 or 3.75 in/s). Figure 4-17 is a simplified block diagram of the main audio for one record/reproduce channel.

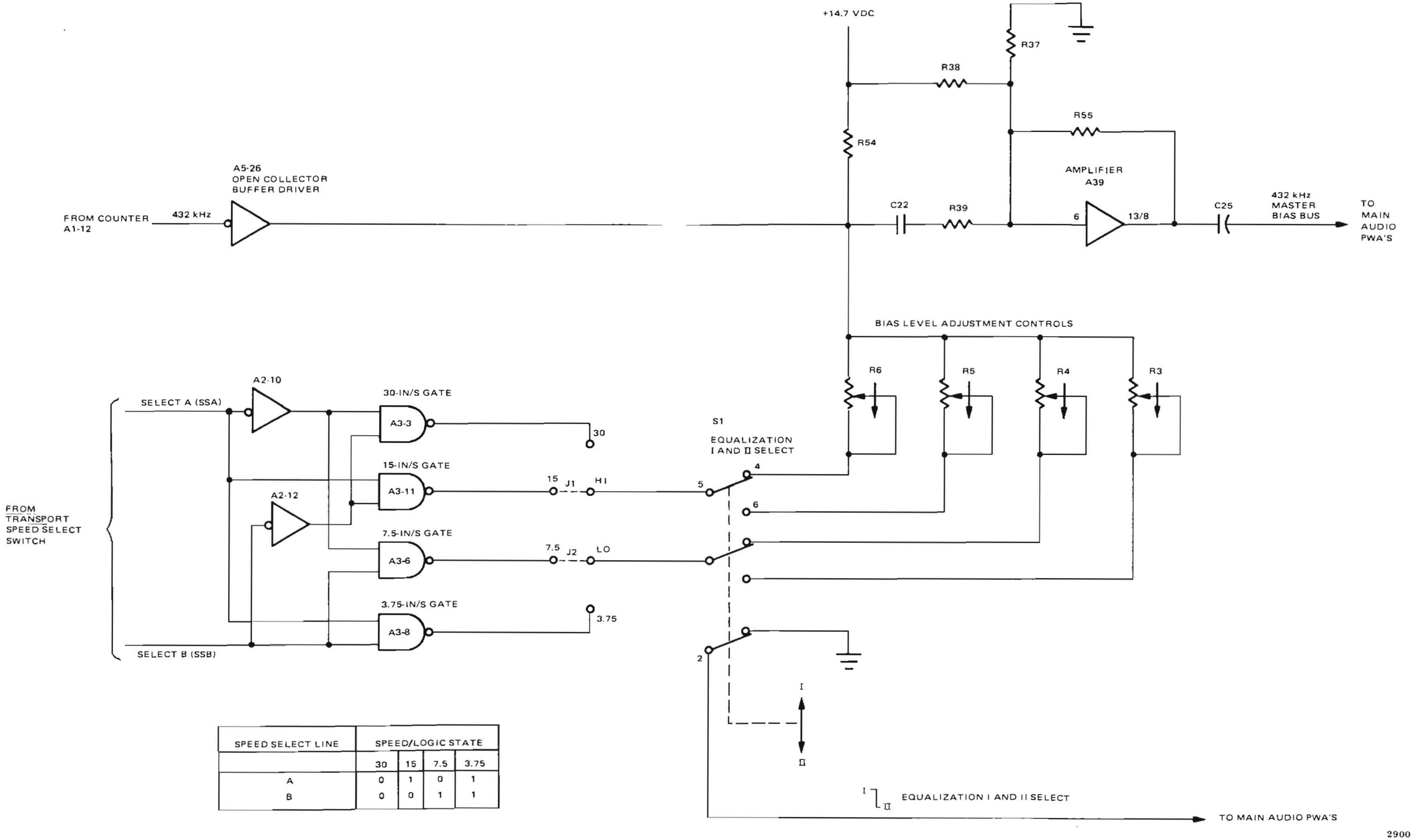
The record circuits receive the system audio input and 432-kHz bias, and provide equalization of the received audio signal to match the required recording equalization at the selected tape speed and/or equalization standard. The record circuits also combine the equalized signal with the 432-kHz bias to provide the drive signal to the record head on the tape transport.

The reproduce circuits receive playback audio from the reproduce head or sel sync audio from the record head, as selected by the operator. The reproduce circuits provide the required playback equalization of either tape signal to match the selected tape speed and/or equalization standard. The selected tape signal is sent to the output amplifier circuits. Additionally, the unequalized sel sync signal is available at the card-edge connector.

The audio output circuits receive the tape and input signals from the reproduce circuits or input circuits, respectively, and provide selection and buffering of the tape or input signals to the input/output module.

The erase circuit receives the 144-kHz erase signal and provides buffering of the erase signal to the erase head via the erase amplifier. The output of the erase amplifier is fed to the erase head via the erase reed relay. The erase reed relay is normally open. When the safe/record signal is low (record) the erase reed relay is energized and the normally-open contacts are closed to provide a current path for the erase signal to the erase head. The control signal for the erase reed relay is provided via the control logic on the main audio board.

The control logic receives the safe/record, tape speed, and tape/input selection signals and generates the control signals to the circuits on the audio main and PADNET assemblies. The control logic provides the tape or input switching signals to the audio output circuits, decoded transport tape-speed selected signals to the record and reproduce circuits, and ramping and control signals to the record circuits. The control logic also contains the pick-up recording capability (PURC) circuits. The PURC circuits eliminate overlaps and erased gaps in recordings when inserting (dubbing) new material within previously-recorded programs. In a recorder system without PURC, initiating the record mode energizes the erase and record heads simultaneously. Since there is a physical distance between the erase head and the record head, a period of over-recording on the unerased tape occurs and, when the dubbing is terminated, an erased gap is left in the program. The length of over-recording and the erased gap on the tape is determined by the distance between the erase and record heads and the transport tape speed.




| SPEED SELECT LINE | SPEED/LOGIC STATE | | | |
|---|---|---|---|---|
| | 30 | 15 | 7.5 | 3.75 |
| A | 0 | 1 | 0 | 1 |
| B | 0 | 0 | 1 | 1 |

Figure 4-16. Master Bias Bus, Two-Speed Simplified Schematic (PWA 5)

Table 4-6. Speed Jumper Placement and Bias Switch Setting, Audio Control PWA 5

| 2-SPEED OPERATION | | | |
|---|---|---|---|
| SPEED | SET JUMPERS TO DESIRED SPEED | MASTER BIAS (ADJUST S1 POSITION I) | MASTER BIAS (ADJUST S1 POSITION II) |
| HI SPEED | J1 – 30, 15, 7.5 | R6 | R5 |
| LO SPEED | J2 – 15, 7.5, 3.75 | R4 | R3 |
| NOTE: J3 and J4 to be jumpered to the S (store) positions. | | | |

| 4-SPEED OPERATION | |
|---|---|
| JUMPER | MASTER BIAS (ADJUST S1 POSITION I ONLY) |
| J1 – 30 | R6 |
| J3 – 15 | R5 |
| J2 – 7.5 | R4 |
| J4 – 3.75 | R3 |

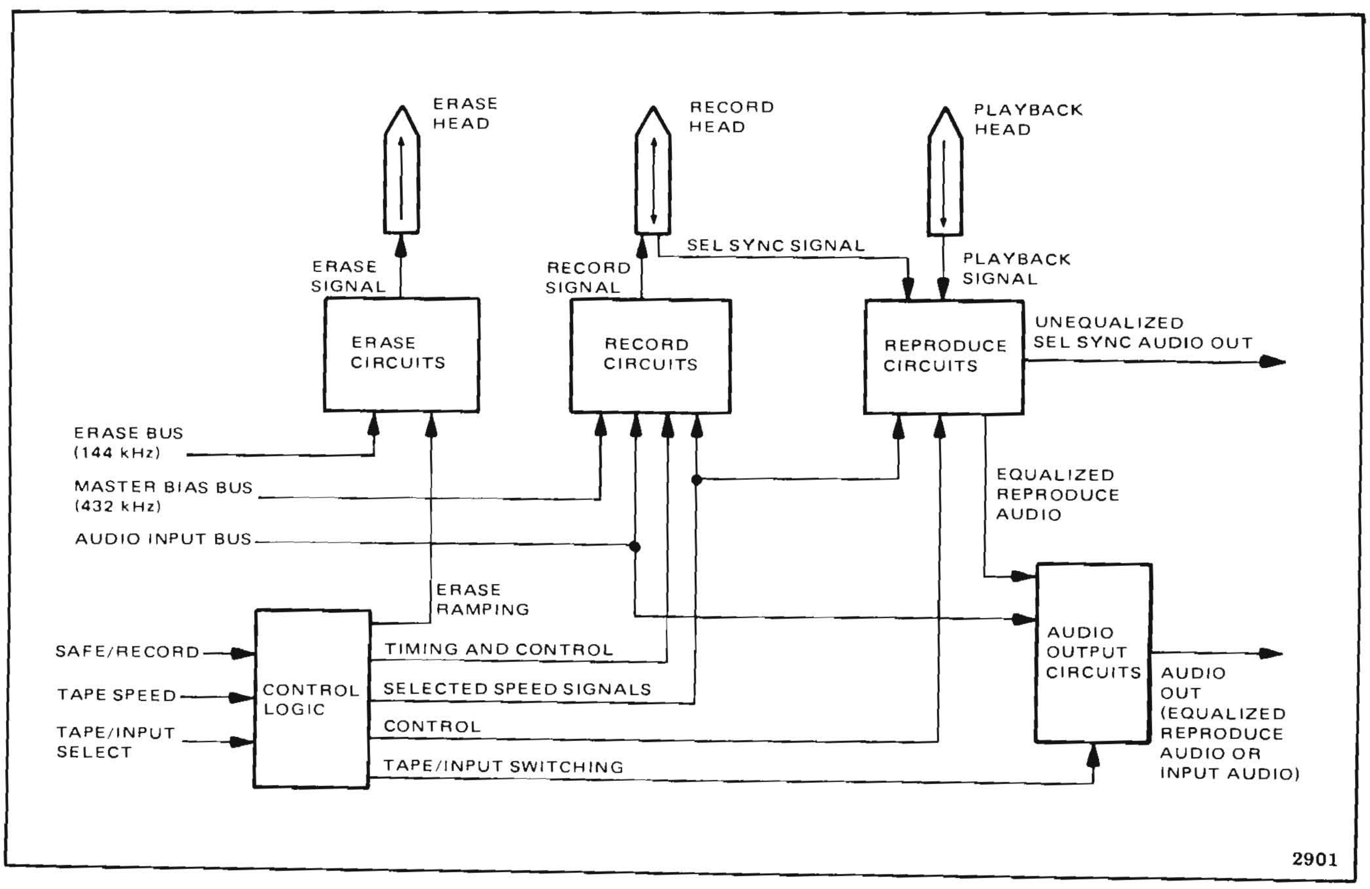



Figure 4-17. Main Audio Simplified Block Diagram

The PURC circuits eliminate the over-recording and erase gap by generating a delay between the time that the erase ramping is initiated and the bias/audio ramping is initiated. When the recorder/reproducer goes into the record mode, the erase ramp up is initiated first; then, after a delay determined by the selected tape operating speed, the bias/audio ramp up is initiated. When the recorder/reproducer is switched out of the record mode, the erase ramp down is initiated first; then, after a delay determined by the selected tape operating speed, the bias/audio ramp down is initiated. In this manner, the effect of the physical difference between the erase and record heads is cancelled and the overlap and gap are eliminated from the dubbed portion of the recording.

**4-69. Main Audio Circuit Details**

Each of the four channels of the main audio is identical. The main audio circuits for channels 1 through 4 are located on PWA 1 through PWA 4, respectively, for each channel. The following paragraphs describe the main audio circuits that comprise a single channel. Each channel contains one audio main board and plug-in PADNET assembly. Drawing 4840378 is the schematic diagram for the audio main board; drawing 4840379 is the schematic diagram for the two-speed PADNET assembly; and drawing 4840468 is the schematic diagram for the four-speed PADNET assembly.

**4-70. Control Logic.** The control logic generates ramping, timing, and switching signals for the main audio. As shown in Figure 4-18, the control logic contains the ramping, PURC delay, tape-speed decode, and output amplifier switching logic.

**4-71.** *Speed Decode Logic.* The speed decode logic is contained on the PADNET assembly. As shown in Figure 4-18, the speed decode logic receives the selected speed signals, SSA and SSB, from the transport unit speed selector and decodes the four possible combinations of the two signals to provide selection of networks within the PADNET assembly. These speed signals are active low. When SSA and SSB are both low (30 in/s), the output of NAND gate A2-11 goes low and NAND gates A2-3, A2-4, and A2-10 are high. In a similar manner, each of the NAND gates provides a low signal which corresponds to a selected tape speed as determined by the selected speed signals from the tape transport. The individual selected speed signals (30, 15, 7.5, and 3.75 in/s) are used to gate different timing networks in the PURC circuit. The decoded 30 in/s and 15 in/s are also used in the reproduce equalizer circuits to gate additional compensation into the equalization networks. The four decoded speed signals are used on the PADNET for selection of high and low speed equalization network via jumpers P1 and P2 and J1 and J2, respectively.

The standard PADNET assembly provides a choice of any two standard operating speeds that are compensated by the high- and low-speed equalization networks on the PADNET. The operating tape speeds are selected by jumpers on the PADNET. The high-speed equalization circuits may be enabled at 30, 15, and 7.5 in/s. The low-speed equalization circuits may be enabled at 15, 7.5, and 3.75 in/s. If the tape operating speed selected at the tape transport does not correspond to the speed selected on the PADNET to enable the high- or low-speed equalization, the recorder/reproducer is inhibited from operating in either play or record modes and the lockout indicator on the control unit is lit. The lockout signal, ISL, is generated by a NAND gate consisting of Q14 and CR8 through CR10. The decoded high- and low-speed equalization network selection signals provide the inputs to NAND gate Q14/CR8-10. If neither high- nor low-speed selected signals are low (0 Vdc), the output of NAND gate Q14/CR8-CR10 goes low denoting that a tape speed has been selected at the transport which does not correspond to a selected speed on the PADNET. All logic integrated circuits (IC's) on the PADNET are CMOS-type circuits; therefore, the logic levels in the circuits range from +15 Vdc (high) to 0 Vdc (low).

**4-72.** *Erase Ramping.* The turn on and turn off of the erase signal is controlled by the SAFE/REC signal from the Audio Control PWA 5. When the channel is not in the record mode, the SAFE/REC signal is high. The SAFE/REC signal, through resistor R42, is applied to a summing point at the inverting input of erase ramping amplifier A7-14. Erase ramping amplifier A7-14 and ramping network C36/VR1/VR2/CR11/C38/R44 generate the ramp and control signals for the erase ramping

switch Q14 and erase head relay driver Q17/VR5. The ramping network provides feedback from the output of the erase ramping amplifier A7-14 back to the summing point at the inverting input of the amplifier. When the SAFE/REC signal is high (not record mode), the output of the erase ramping amplifier A7-14 is nominally −10 Vdc. The −10 Vdc, via the PADNET, is applied to erase head relay driver Q17/VR5. The −10 Vdc biases the transistor off, which keeps relay K2 de-energized. The −10 Vdc, via the ramping network, enables a negative bias to be applied through resistor R70 and diode CR17 to the base of erase ramping switch Q14. Transistor Q14 operates in the inverted mode and conducts when the negative bias is applied, thereby shunting the 114-kHz erase signal, at the input to erase amplifier A10/Q18/Q19, to ground.

When the channel is switched into the record mode, the SAFE/REC signal goes low. When the SAFE/REC signal goes low, the low-going input supplied to the inverting input of erase ramping amplifier A7-14 causes the output of the amplifier to start rising toward the +10-Vdc level. The output of erase ramping amplifier A7-14 is fed back to the summing point at the inverting input and to erase switch Q14 via the ramping network. The ramping network, together with erase ramping amplifier A7, forms an active integrating amplifier that generates an erase ramping signal that is applied to the base of Q14. This signal is used to shape the 114-kHz erase signal applied to the emitter of Q14. The controlled base drive produces an amplitude-controlled ramped 114-kHz signal which is applied to erase amplifier A10/Q18/Q19. The erase ramping signal also controls the timing for energizing erase head relay K2 via erase head relay driver Q17/VR5. When the channel is switched out of the record mode, the SAFE/REC signal goes high. The positive-going input to the summing point at the inverting input of erase ramping amplifier A7-14 causes the output of the integrating amplifier formed by the erase ramping amplifier A7-14 and the ramping network to swing toward negative 10 Vdc. The negative-going ramp generated by the integrating amplifier provides the turn-off ramp for the 114-kHz erase signal to the input of the erase amplifier via transistor switch Q14. The negative-going ramp also provides the timing to de-energize erase head relay K2 via erase head relay driver Q17/VR5.

**4-73.** *Record Ramping and PURC Logic.* The record ramping and pick-up record capability (PURC) logic generates the appropriate ramping signals for the controlled ramping up and down of the bias to the record circuits and for timing of the PURC delays. All control sequences are initiated when the status of the channel SAFE/REC signal, generated by the Audio Control PWA, changes. Figure 4-19 is a timing diagram of the ramping and PURC delay signals.

As discussed previously, operational amplifier A7-14 is connected to form an active integrator to generate the erase ramping control for erase ramping switch Q14, and to provide the control for the erase head relay K2 via erase head relay driver Q17/VR5. Operational amplifier A7-8 is connected to form an active integrator that provides the required ramping control to bias ramping switch Q7, and control the operating sequence of the record head reed relay K1, sel sync shunt switch Q6, record audio switch Q9, and bias command status switch Q8/Q10. Operational amplifier A7-1 forms an active integrator which, in conjunction with hysteresis switch A7-7 and timing selection FET Q8 through Q11, provides the selected delay timing for PURC operation.

When the recorder/reproducer goes into the record mode, the SAFE/REC signal goes low and turns on ±15V switch Q7 which switches the −15 Vdc at the input to PURC delay amplifier A7-1 to +15 Vdc via a selectable resistor network. Jumper plug P3 is used to select PURC operation when the recorder is switched into record mode. When the jumper plug is in the PURC position, +15 Vdc from the ±15V switch Q7 is supplied to the resistor network comprised of four resistors, R36 through R39. One of the four resistors is selected by the decoded speed select signals specifying the tape operating speed and supplies a constant current, as determined by the selected resistor, to the input of the PURC delay amplifier A7-1. When the jumper is in the NORM (PURC disabled) position, positive 15 Vdc from the 15-Vdc switch Q7 is supplied to PURC delay amplifier A7-1 through resistor R30 independent of the selected tape operating speed. Resistor R30 or resistors R36 through R39, depending on whether PURC operation is selected via jumper plug P3, provide different delay times in conjunction with the integrating amplifier formed

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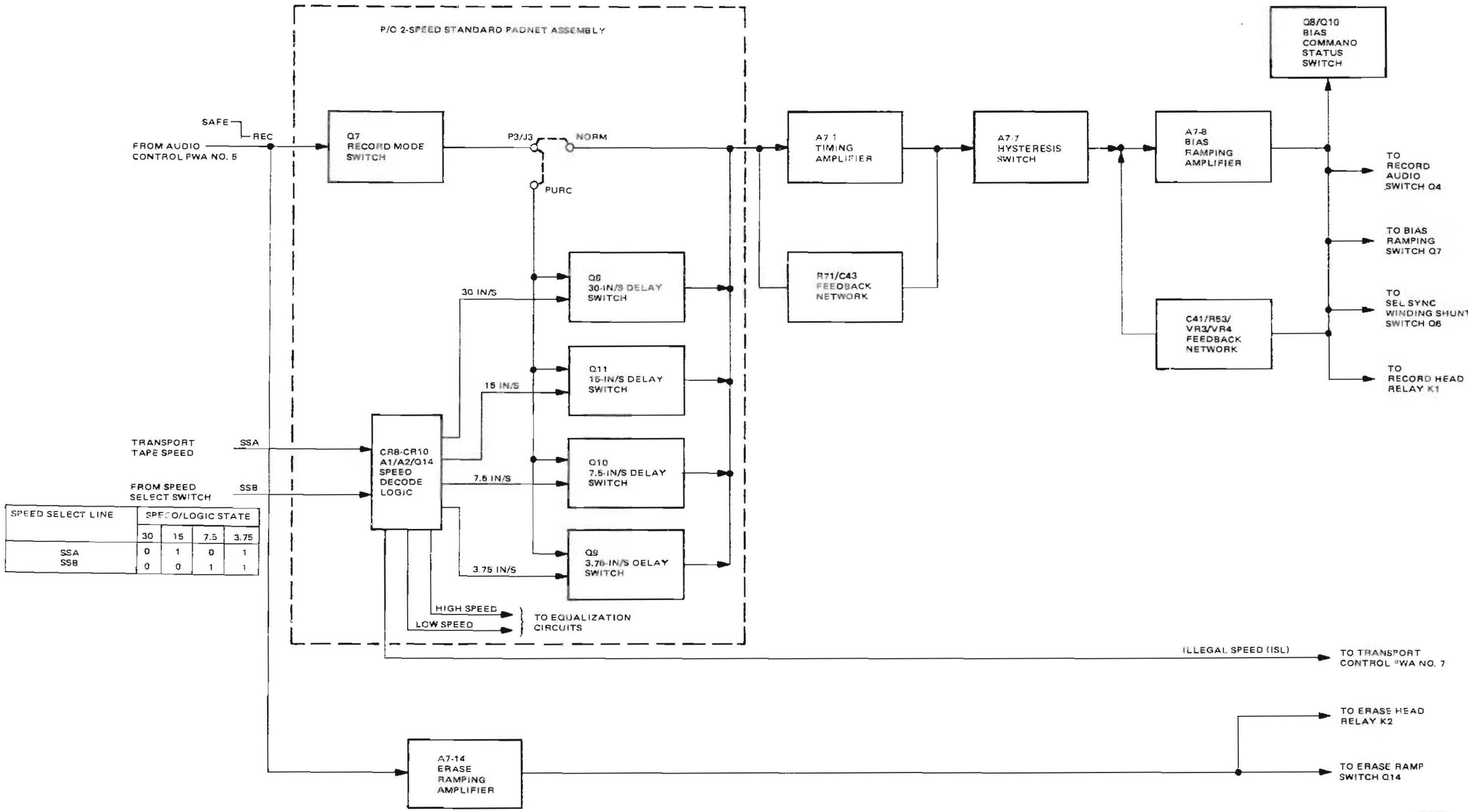



| SPEED SELECT LINE | SPEED/LOGIC STATE | | | |
|---|---|---|---|---|
| | 30 | 15 | 7.5 | 3.75 |
| SSA | 0 | 1 | 0 | 1 |
| SSB | 0 | 0 | 1 | 1 |

Figure 4-18. Main Audio Control Logic (with 2-Speed Standard PADNET), Simplified Block Diagram

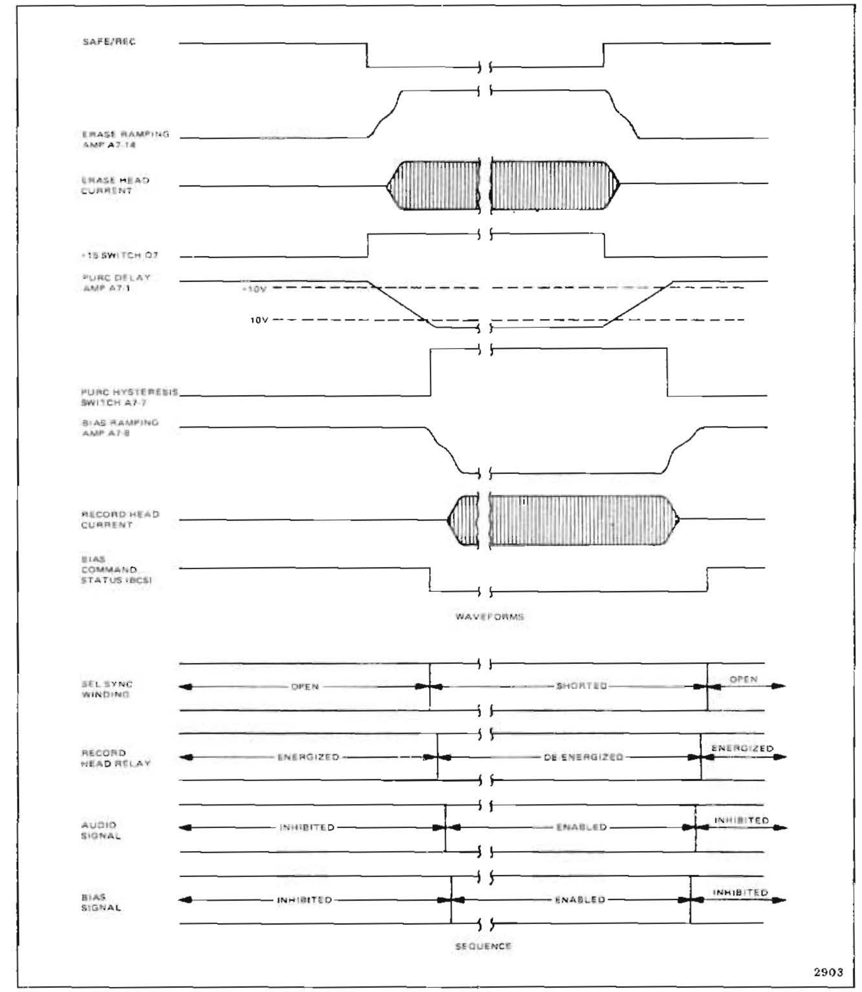



Figure 4-19. Record Ramping and PURC Delay Timing

by PURC delay time amplifier A7-1 with resistor R71 and capacitor C43. Resistors R36 through R39 are individually selected by FET switches Q8 through Q11 by the decoded speed selected signals. When the corresponding selected tape speed signal goes low, the associated FET switch is turned on and provides a current path through the resistor to the input of PURC delay amplifier A7-1.

When the recorder/reproducer is switched into the record mode, the SAFE/REC signal goes low and switches +15 Vdc, via +15V switch Q7 and resistor network R30/R36-R39, to PURC delay amplifier A7-1. PURC delay amplifier A7-1 generates a negative-going ramp. The slope of the ramp is determined by the selected resistor in resistor network R30/R36-R39 and C43/R71. The ramp from PURC delay amplifier A7-1 goes to the PURC hysteresis switch A7-7. The PURC hysteresis switch A7-7 is a comparator, which compares the level of the delay ramp with one of two levels. The two comparison levels are derived by a positive feedback network that decreases the output level of the PURC hysteresis switch A7-7 by approximately two-thirds. When the recorder/reproducer is in the safe mode (SAFE/REC signal is high), the output of the PURC hysteresis switch A7-7 is low (approximately −15 Vdc). The comparison reference level fed back to the input of the comparator is approximately −10 Vdc during the safe mode and remains at −10 Vdc until the level of the negative-going ramp exceeds −10 Vdc, at which time the output of PURC hysteresis switch A7-7 will go to +15 Vdc. The slope of the ramp, therefore, determines the difference between the time that the SAFE/REC signal goes low and the time that the output of PURC hysteresis switch A7-7 goes high.

As long as the recorder/reproducer remains in the record mode (SAFE/REC signal low), the output of the PURC hysteresis switch remains high (+15 Vdc) and a new reference level of +10 Vdc is fed back to the input of the comparator. The positive-going edge of the signal from PURC hysteresis switch A7-7 initiates the bias ramp, which controls the timing of record signals. The bias ramp is generated by active integrator bias-ramping amplifier A7-8. When the output of PURC hysteresis switch A7-7 goes high, a negative-going ramp voltage is generated by bias-ramping amplifier A7-8. Bias and current-limiting of the signals by electronic switches in the record circuits control the turn-on and turn-off sequence of operations. As the bias ramp goes negative, the following operations occur in the order given.

1. Status switch Q8/Q10 is turned on and supplies a logic low to bias command status line—BCS.

2. Sync shunt switch Q6 is turned on and shorts the sel-sync winding on the record head.

3. Record head relay Q11/K1 is de-energized, which removes the short across the record winding of the record head.

4. FET switch Q9 is switched on and enables the audio input to record amplifier A9/Q12/Q13.

5. Bias switch transistor Q7 is ramped off and provides a corresponding ramping up of the bias input to record amplifier A9/Q12/Q13.

When the recorder/reproducer is switched out of the record mode, the SAFE/REC signal goes high and turns off 15-Vdc switch Q7. With the +15-Vdc supply to resistor network R30/R36-R39 turned off, −15 Vdc is applied to the selected input resistor which provides the current to PURC delay amplifier A7-1. With −15 Vdc at the input, PURC delay amplifier A7-1 generates a positive-going ramp from −15 Vdc to +15 Vdc. The slope of the positive-going ramp is determined by the selected resistor in resistor network R30/R36-R39 and C43/R71. Since the −15 Vdc is applied through the same resistor network as the +15 Vdc, the slope of the positive-going ramp when the recorder/reproducer is switched out of the record mode is the same as the slope of the negative-going ramp when the recorder/reproducer is switched into the record mode.

The positive-going ramp goes to hysteresis switch A7-7. During record, the output of hysteresis switch A7-7 is +15 Vdc. Therefore, the comparison reference level for hysteresis switch A7-7 is shifted to +10 Vdc in the same manner that the −10-Vdc reference was generated going into record. When the level of the positive-going ramp exceeds

+10 Vdc, the output of PURC hysteresis switch A7-7 goes rapidly low and initiates a positive-going ramp, which is generated by bias ramping amplifier A7-8. As the bias ramp goes positive, the following operations occur in the order given.

1. Bias switch transistor Q7 is ramped on, which ramps down the bias input to record amplifier A9/Q12/Q13, thereby removing the bias signal to the amplifier.

2. FET switch Q9 is biased off, which removes the audio input to record amplifier A9/Q12/Q13.

3. Record head relay Q11/K1 is energized, thereby shunting the record head windings.

4. Sync shunt switch Q6 is turned off and opens the short across the sel-sync windings of the record head.

5. Status switch Q8/Q10 is turned off, removing the logic low from the bias command status line (BCS), which allows bias command status line BCS to go high.

**4-74.** *Record Circuits.* As shown in Figure 4-20, the main part of record equalization is performed by amplifier A6-6 in conjunction with an active differentiator formed by amplifier A5-6, input capacitor C5, and feedback resistor R41.

The audio input signal is split into three paths. The first path is via R39 to the summing node (pin 2 of A6-6). The second path is to the input network C5/R41 of the active differentiator. The third path is to the summing node of A6-6 via C13/R54/R55, with alternate paths selected by S1 and FET switches Q12 and Q13 for high- and low-speed switching equalization, respectively.

The output from the active differentiator A5-6 will, for a constant amplitude signal, rise 6 dB per octave with increasing frequency. Time constant components C5/R41 limit the maximum frequency of the rise. This output signal is then applied to equalizer potentiometer controls R15 and R18, which are the main high-frequency equalizer controls for high-speed and low-speed operation, respectively. The setting of these equalizer controls determines how much of the differentiated signal is summed with the direct signal, via R39, supplied to the summing node of A6-6. Selection between the output of R15 or R18 is accomplished by FET switches Q12 and Q13, respectively.

A series of switch selectable networks formed by R16/R17/C8/C9 (switched by S1-1 and S1-3 for high speed) and R19/R20/C10/C11 (switched by S1-4 and S1-6 for low speed) form additional frequency dependent feedback around A6-6 to the summing node of A6-2. Selection for high or low speed is also accomplished by FET switches Q12 and Q13.

The network formed by C13/R54/R55 and selected for high-speed operation by S1-2 and for low-speed operation by S1-5, also provides separate frequency dependent preset equalization. In this instance, the network effectively appears in parallel with R39.

The networks switched by S1-1 and S1-4 provide mid- to high-frequency shelf down for high and low speeds, respectively. Switches S1-3 and S1-6 provide selectable constant current or 3,180-$\mu$s low-frequency pre-emphasis for high and low speeds, respectively. Switches S1-2 and S1-5 provide a mid- to high-frequency shelf up for high and low speeds, respectively. Table 4-7 is a list of the switch settings for preset equalization network settings.

The equalized audio from amplifier A6 goes to record gain control R12 on the PADNET assembly. The audio from the gain control potentiometer R12 (REC GAIN) on the PADNET assembly goes through R47 back to the audio main board to FET switch Q9, which gates the audio to the summing junction of amplifier A9 in the recording amplifier. FET switch Q9 gates the audio under control of audio switch control network R62/CR9/C56, which receives a control signal from bias ramping control amplifier A7-8 in the control logic. The recording amplifier A9/Q12/Q13 is a wide-band voltage amplifier consisting of operational amplifier A9 and a complementary driver output amplifier Q12/Q13.

The 432-kHz bias signal is received at the Main Audio PWA, where it is routed to the bias

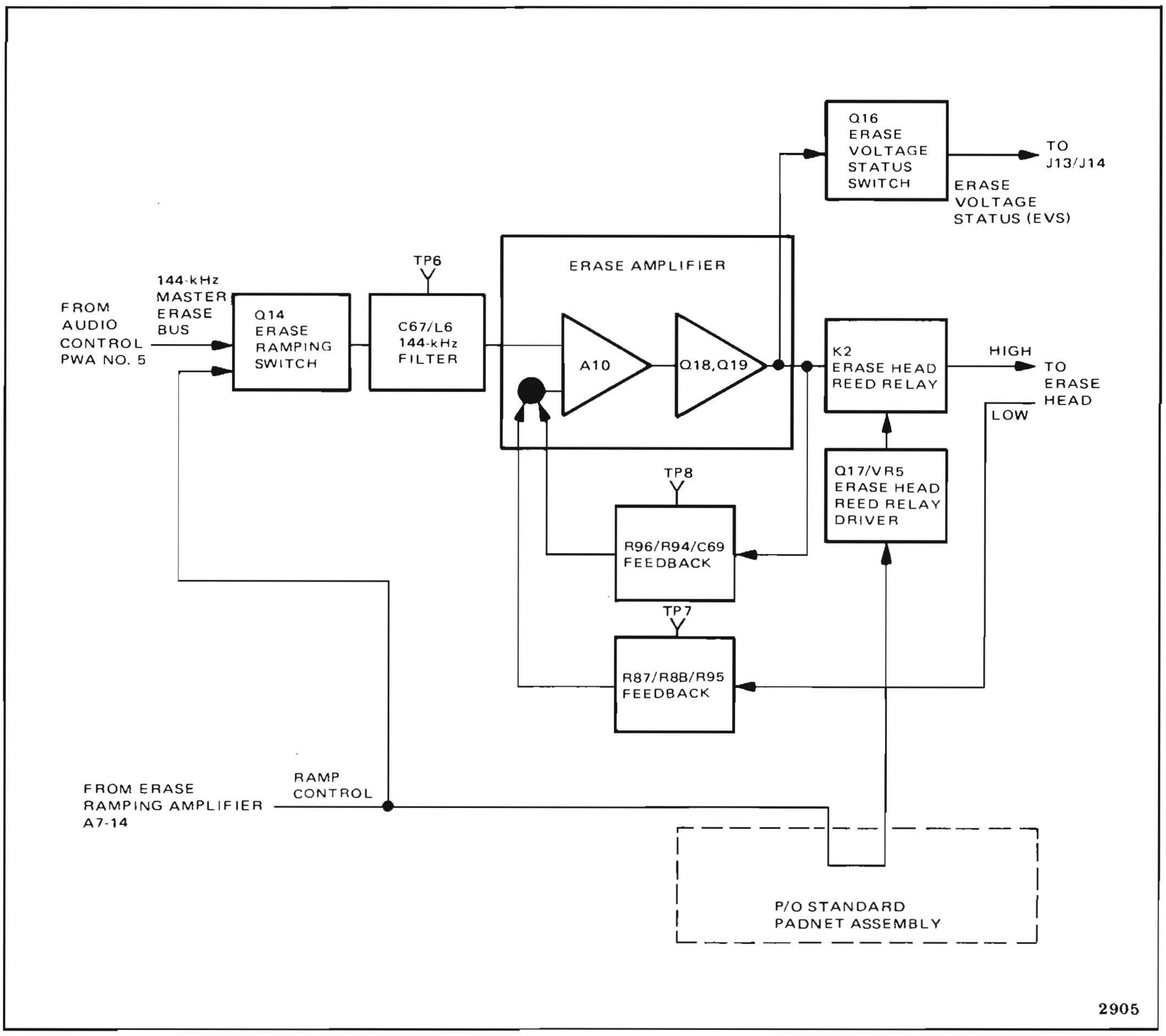



**Figure 4-21. Erase Circuit, Simplified Block Diagram**

inverted mode, acts as a shunt across filter C67/L6 which ramps the erase bias on and off. The filtered 144-kHz signal, when ramped on, goes to erase amplifier A10/Q18/Q19.

Erase amplifier A10/Q18/Q19 consists of amplifier A10 and complementary pair transistor driver amplifier Q18/Q19 arranged to form a feedback-controlled current driver to the erase head. The filtered 144-kHz signal is applied to the noninverting input of amplifier A10. Feedback voltage from the output of driver amplifier Q18/Q19 via resistor R96 is summed with the current feedback developed across resistor R87 via resistor R88 at the inverting input of amplifier A10. The output 144-kHz erase signal from driver amplifier Q18/Q19 goes through capacitor C71 and contacts of reed relay K2 to the erase head. During record, reed relay K2 is energized by erase head relay driver Q17/VR5. The output of the driver

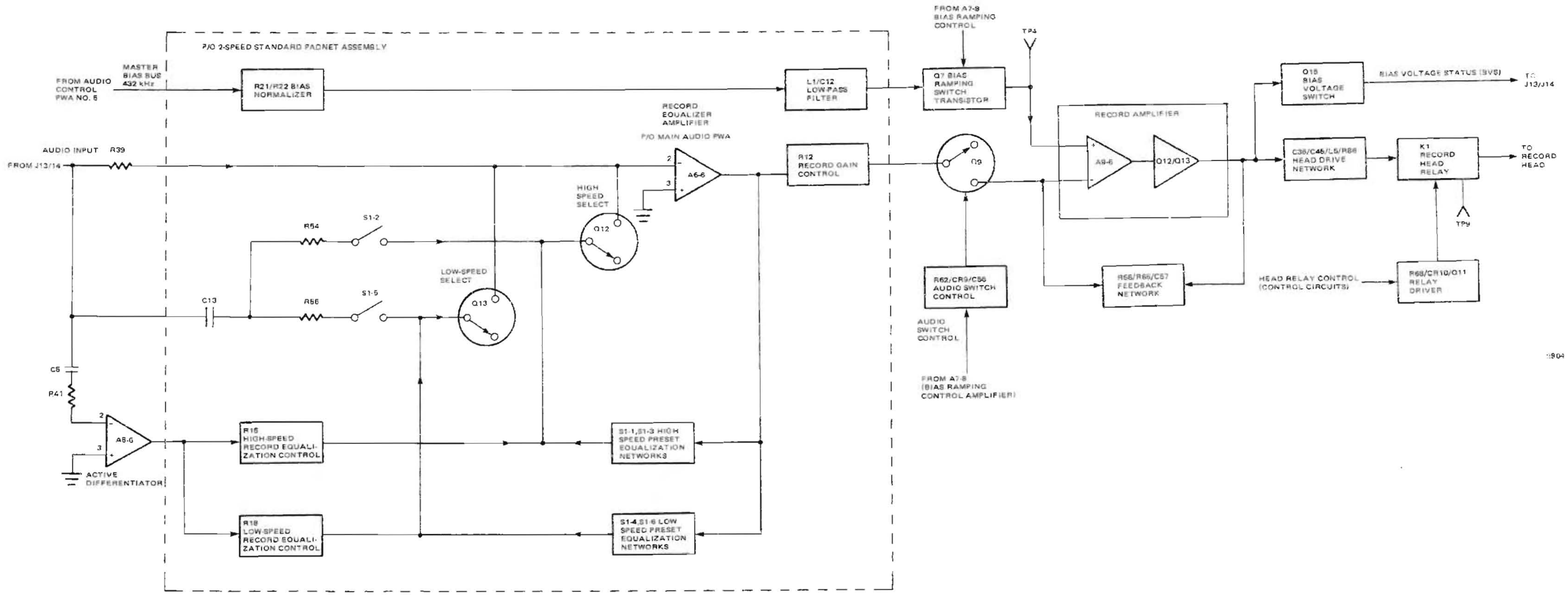



Figure 4-20. Audio Record Circuits, with 2-Speed Standard PADNET, Simplified Block Diagram

Table 4-7. Preset Equalization Network Settings

| PRESET RECORD EQUALIZATION | | |
|---|---|---|
| S1-1<br>S1-2<br>S1-3 | SHELF DOWN<br>SHELF UP<br>3180/∞ | HI SPEED |
| S1-4<br>S1-5<br>S1-6 | SHELF DOWN<br>SHELF UP<br>3180/∞ | LO SPEED |
| Shelf up or shelf down will be selected with the switch in the "ON" position. Infinity (∞), no low frequency boost will be selected with the switch "ON" and low frequency boost (3180-μs time constant) with the switch "OFF." | | |

normalizing and filtering circuits on the PADNET. Bias normalizing resistor R21/R22 provides level setting of the received 432 kHz from the master bias bus via BIAS NORM potentiometer R21. The level normalized bias signal is then filtered by bandpass filter L1/C12 on the PADNET. The filtered bias is sent to bias ramping switch transistor Q7 on the Main Audio PWA. Bias ramping switch transistor Q7 operates in the inverted mode and, under control of the bias ramp control signal from ramping amplifier A7-8 in the control logic, provides ramping of the bias signal to operational amplifier A9 where it is effectively added to the audio which is applied to the inverting input. The combined audio/bias signal from operational amplifier A9 is sent to complementary driver output amplifier Q12/Q13, which buffers the signal to head drive network C30/C45/L5/R86. Additionally, part of the signal from operational amplifier A9 is also sent to bias voltage switch Q15 and to feedback network R66/R65/C67. This network (R66/R65/C67) provides negative feedback around the record amplifier A9/Q12/Q13. Bias voltage present on the output of the record amplifier also provides the control signal to the base of transistor Q15 which, when bias is present, will provide a low on the bias voltage status (BVS) line from the audio main board.

The output of the record amplifier goes to the record head via head drive network C35/C45/L5/R86 and record head relay K1. The head drive network provides a constant head current over a wide frequency range of the output of the record amplifier. Inductor L5 decouples resistor R86 so that the head inductance forms a resonant circuit with capacitor C45 at the bias frequency (432 kHz).

Record head relay K1 shunts the record winding of the head except during record mode. Relay driver R68/CR10/CR14/Q11, under control of the head relay control signal from the ramping amplifier in the control circuits, energizes record head relay K1 when the channel is not in the record mode. When the channel is not in the record mode, the head relay control signal from the control circuits is positive. The positive head relay control signal turns transistor Q11 on. With transistor Q11 conducting, relay K1 is energized and the normally-open contact of relay K1 is closed, providing a short across the record windings. When the channel goes into the record mode, the head relay control signal goes low and turns off transistor Q11, which de-energizes relay K1. When relay K1 is de-energized, the contacts across the record winding are opened and the short across the record winding is removed. When the short circuit across the record winding is removed, the output of the head drive network C35/C45/L5/R86 is supplied to the record winding high input. The return lead (low side) of the record winding returns to ground through a 10-ohm resistor R93. Test point TP9 of the high side of resistor R39 is provided to monitor the current through the record head winding.

4-75. *Erase Circuit.* The erase circuit provides filtering, buffering, and ramping of the 144-kHz erase signal from the master erase bus to the erase head. A simplified block diagram of the erase circuit is shown in Figure 4-21.

As shown in Figure 4-21, the erase circuitry receives 144-kHz from the master erase bus and the erase ramping control from the control logic. The SAFE/REC signal controls, via the erase ramping control amplifier on the control logic, the ramp on and ramp off of the erase signal to the erase amplifier and the erase head. During record mode, the 144-kHz signal goes through resistor R83 to erase ramping switch Q14 and filter C67/L6. Filter C67/L6 is a 144-kHz bandpass filter which removes the harmonics from the received 144-kHz signal. Erase ramping switch Q14, operating in the

amplifier Q18/Q19 also goes to the erase voltage status switch Q16 which supplies a low to the erase voltage status line (EVS) when the erase voltage is present at the output of driver amplifier Q18/Q19.

When the channel is not in the record mode, the 144-kHz from the master erase bus through resistor R83 is shunted to ground by erase ramping switch Q14, and erase head relay K2 is de-energized, which opens the circuit to the winding of the erase head.

4-76. *Reproduce Circuits.* The reproduce circuits provide amplification, selection, and post-equalization of the playback signals. Figure 4-22 shows a simplified block diagram of the reproduce circuits.

As shown in Figure 4-22, the reproduce circuit contains the sel sync head preamplifier, reproduce head preamplifier, and reproduce equalizer amplifier. The reproduce head preamplifier receives the playback signal from the reproduce head and is located on the Main Audio PWA. The sel sync head preamplifier receives the playback signal from the sel sync winding on the record head and is also located on the audio main board. The outputs of the two head preamplifiers go to the standard PADNET assembly where, via the individual sel sync and reproduce gain controls, the signal is applied to the summing point at the input to the reproduce equalizer amplifier through the sel sync and reproduce switching FET's. The reproduce equalizer amplifier provides post-equalization of the selected playback signal. The output of the reproduce equalizer amplifier is fed back, via speed selected equalization and compensating networks located on the PADNET assembly, to the summing point at the input of the reproduce equalizer amplifier. The output of reproduce equalizer amplifier is also sent to the audio output amplifier via erase frequency trap C3/L1 and input resistors R8/R9.

The signal from the sel sync winding on the record head is connected through capacitor C31 to the input of the sel sync preamplifier. Sel sync winding shunt switch Q6 at the input to the sel sync preamplifier consists of transistor switch Q6, operating in the inverted mode which shorts out the sel sync winding during record. Transistor switch Q6 is controlled by the output of the bias ramping control amplifier A7-8 in the control logic. Resistor R33, in parallel with the input to the sel sync preamplifier, provides damping of the sel sync winding at resonance. The sel sync preamplifier consists of transistor Q5 and amplifier A4 arranged as a feedback-controlled voltage amplifier. The signal from the sel sync winding of the record head is fed to the base of transistor Q5. The output from transistor Q5 is fed to the inverting input of amplifier A4. Part of the output from amplifier A4 is fed back to the emitter of transistor Q5 via network C11/C12/C18/L2/R15-R17. The network formed by R15, R16, and C18 provides additional negative feedback to attenuate mid-range and high frequencies, thereby providing a low-frequency boost in the output of sel sync preamplifier to compensate for the inherent roll-off in the reproduce signal from the sel sync windings. Resistor R17, in conjunction with C28/R37, sets the low-frequency gain of the sel sync head preamplifier. Capacitor C12 and inductor L2 in this network form a series-resonant trap at the bias frequency. The output of the sel sync head preamplifier A4, via resistor R49, goes to the unequalized sel sync output at the PWA-edge connector. From here the signal is routed to connector J13/J14. The output of the sel sync head preamplifier, via capacitor C13, goes to the sync gain control R3/R4 located on the PADNET assembly.

In a similar manner, the audio from the reproduce head is amplified by the reproduce head preamplifier consisting of operational amplifier A3 and transistor Q4 arranged to form a feedback controlled amplifier. The audio from the reproduce head goes to the base of transistor Q4 via inductor L3 which provides RFI filtering. Head damping network R36/R34, in parallel with the audio input to the base of transistor Q4, provides adjustable damping of the high-frequency head resonance. The output from amplifier A3 is fed back to the input of transistor Q4 via RC network C24/R31. This RC network, together with RC network C27/R32, sets the ac gain of the reproduce head preamplifier. Another RC network formed by R23/C23 limits the open loop gain of operational amplifier A3.

B6

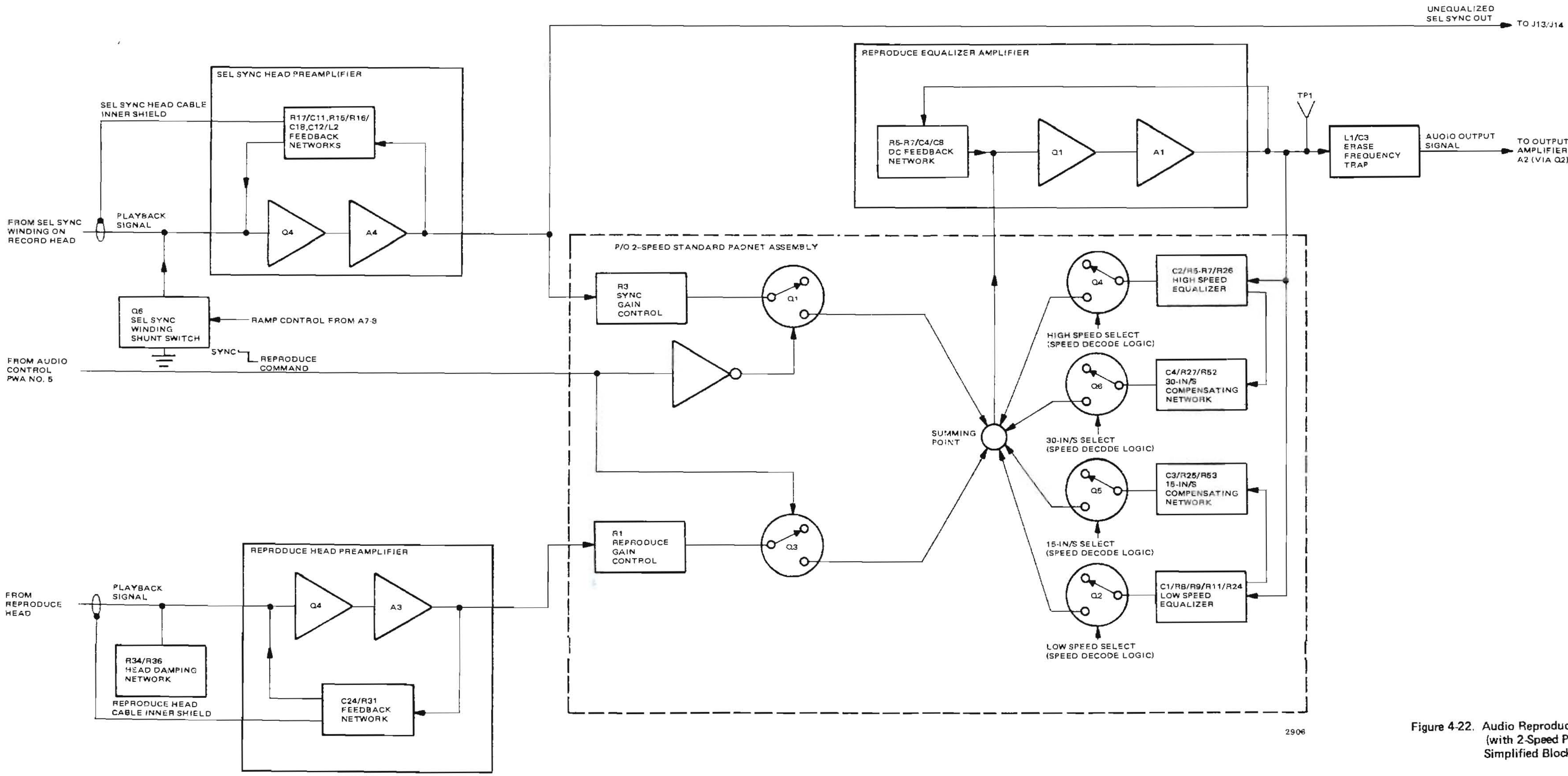



Figure 4-22. Audio Reproduce Circuits (with 2-Speed PADNET), Simplified Block Diagram

The output of the reproduce head preamplifier, via capacitor C7, goes to the reproduce gain control R1 on the PADNET assembly. The PADNET assembly contains the switching for selecting the output of the sel sync head preamplifier or reproduce head preamplifier as the input to the reproduce equalizer amplifier. The PADNET assembly also contains the switching and equalizer networks which provide feedback to the reproduce equalizer amplifier for post-equalization of the reproduce audio. The SYNC/REPRO signal from the audio control assembly, via FET switches Q1 and Q3, selects the signal from either the sync gain control R3 or reproduce gain control R1 as the input to the reproduce equalizer amplifier. The selected playback signal goes to the summing point at the input to the reproduce equalizer amplifier.

The reproduce equalizer amplifier consists of a high-gain, low-noise differential amplifier Q1, operational amplifier A1, and RC network R5-R7/C4/C6. The RC network provides dc feedback to the inverting input of amplifier Q1, which prevents dc output saturation in the event that power is applied with the PADNET not installed. The summing point at the input to amplifier Q1 also receives dc feedback via the selected equalizing network.

The reproduce equalization network contains two post-equalization networks, one for high speed and one for low speed. The high speed and low speed post-equalization feedback networks are selected by FET switch Q4 and FET switch Q2, respectively, which are gated by the decoded high- and low-speed selection signals from the speed decode logic. When 30- or 15-in/s speeds are selected, additional equalization is required to compensate for secondary gap effect which is more pronounced at these speeds.

The 30-in/s and 15-in/s signals from the speed decode logic enable additional equalization, via FET switches Q6 and Q5, respectively, to be inserted in parallel to the high- or low-speed equalizing feedback loop. The output from the reproduce equalizer amplifier is applied to the summing junction of the output amplifier via gain setting resistors R8 and R9 when the tape selection FET switch Q2 is in the tape mode. An LC network L1/C3, in conjunction with R8, forms a series-resonant trap at the erase frequency for the signal sent to FET switch Q2.

4-77. *Audio Output Circuit.* The audio output circuit consists of FET switches Q3 and Q2, audio output amplifier A2, and feedback network R11/C9. Figure 4-23 is a simplified block diagram of the audio output circuit. FET switches Q3 and Q2 provide selection of either tape or input signals to be buffered by audio output buffer A2 under control of the $\overline{\text{TAPE}}$/TAPE and $\overline{\text{INPUT}}$/INPUT command signals from Audio Control PWA 5. FET switch Q2 selects the off-tape signal from the reproduce equalizer amplifier when the $\overline{\text{TAPE}}$/TAPE command goes low. For monitoring, FET switch Q3 selects the audio input signal to the record circuits when the $\overline{\text{INPUT}}$/INPUT signal goes low. FET switches Q2 and Q3 will never both be turned on at the same time; however, both switches may be turned off simultaneously. Diode CR1 at the input to FET switch Q2 provides limiting, when Q2 is turned off, of positive signal peaks to ensure that FET switch Q2 is not turned on by the signal peaks. When FET switch Q2 is turned on by the $\overline{\text{TAPE}}$/TAPE signal, diode CR1 will not be forward biased because diode CR1 is essentially at the virtual ground of the summing junction. In a similar manner, diodes CR2 and CR20 at the input of FET switch Q3 provide a symmetrical clamp for the audio input to the switch which prevents the audio peaks from turning on FET switch Q3.

The selected audio, either tape or input, goes to the inverting input of audio output buffer A2 which provides, via resistor R12, the audio output signal from the Main Audio PWA. Part of the audio output signal is fed back to the input of audio output buffer A2 by feedback network R11/C9. The voltage feedback from this network, together with resistors R22 or R8/R9 selected by FET switches Q3 or Q2, sets the required closed loop gain of audio output buffer A2.

### 4-78. 4-Speed/Dual-Speed PADNET (Accessory)

The 4-speed/dual-speed PADNET may be used in place of the 2-speed PADNET to allow greater flexibility in the selection of biased and equalized recording and reproducing circuitry. The 4-speed/dual-speed PADNET consists of the following circuits:

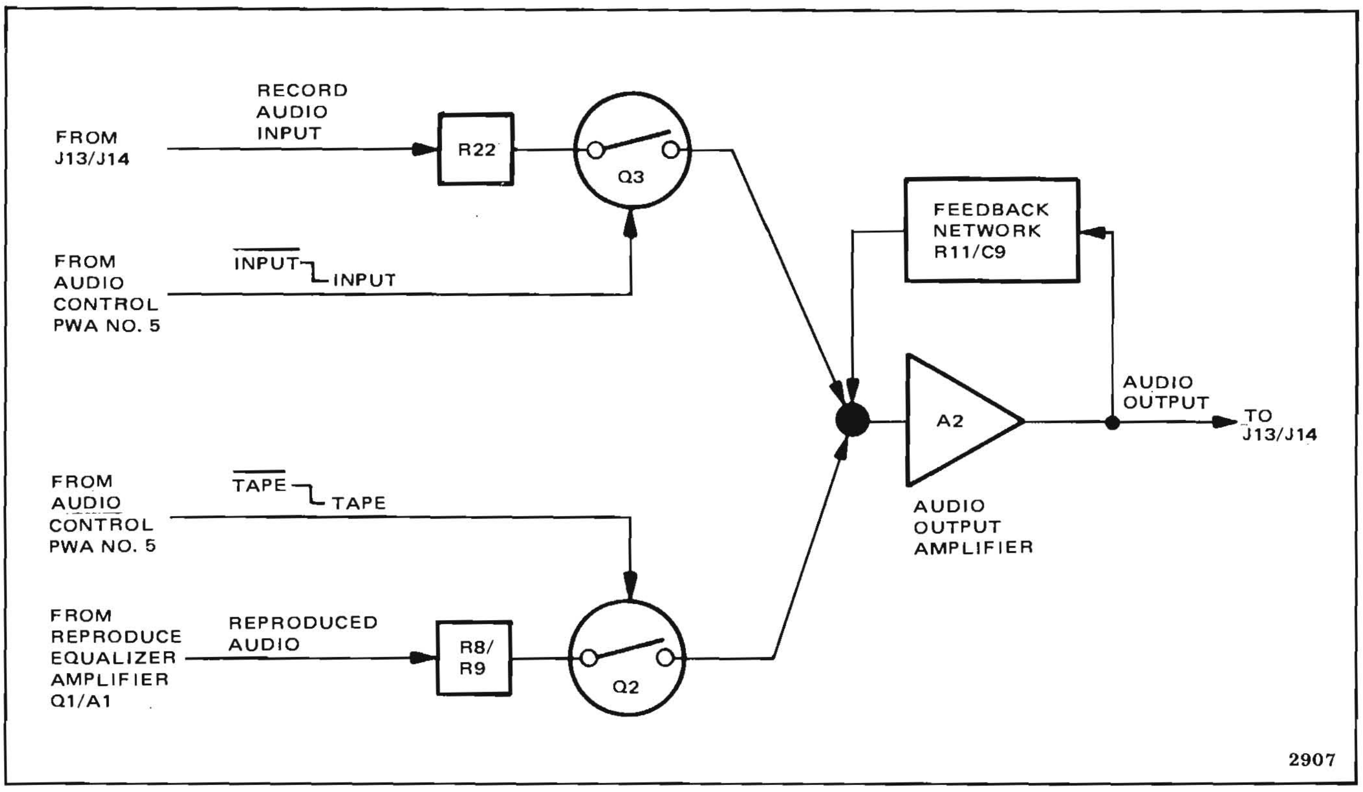



**Figure 4-23. Audio Output Circuit, Simplified Block Diagram**

1. tape speed select
2. record
3. reproduce
4. illegal speed signal generator
5. PURC
6. bias normalizing and filtering

Figure 4-24 is a simplified block diagram of the 4-speed/dual speed PADNET.

**4-79. Tape Speed Select Circuits (See Figure 4-25).** The tape speed select circuits accept the tape speed selected by the operator on the tape transport and route this speed signal to circuits within the 4-speed/dual-speed PADNET. The selected speed from the speed-select rotary switch enters the speed decoder A5 as a binary code (BCD), is decoded and routed to the speed select switch S2/S3 and to the mode select multiplexer A6. The S2/S3 speed select switch also inputs a 4-speed (4S) select signal to speed decoder A5 when 4-speed operation has been selected. The A8 dual speed select circuits utilize the S2/S3 speed select switch positions and the bias switch on PWA 1, 2, 3, or 4 (depending on which audio card is used) to activate the appropriate dual speed circuits. The output from A8 will be two speed selected signals that are routed to A6 mode select multiplexer. The 4S/dual-speed select signal from the A5 speed decoder will select either the dual speed input from A8 or the selected 4-speed (4S) from A5. The selected speed from A6 is routed to appropriate circuitry.

**4-80. Detailed Circuit Discussion (See Figure 4-26).** The BCD code, representing the operator-selected tape speed, enters the 4-speed/dual-speed PADNET on pins 11 and 12 and is routed to pins 2 and 3 of A5. See the table below for the decoded speed signal. When 30 in/s is selected on the speed-select rotary switch pins 2 and 3 of A5 will both go low. Pin 4 of A5 will go low and be impressed on pin 6 of A6. Pins 5, 6, and 7 remain high and these highs are felt on pins 4, 2, and 15 of A6, respectively. With speed select switch S2 or S3 in the 4S position, pin 13 of A5 goes low and pin 9 of

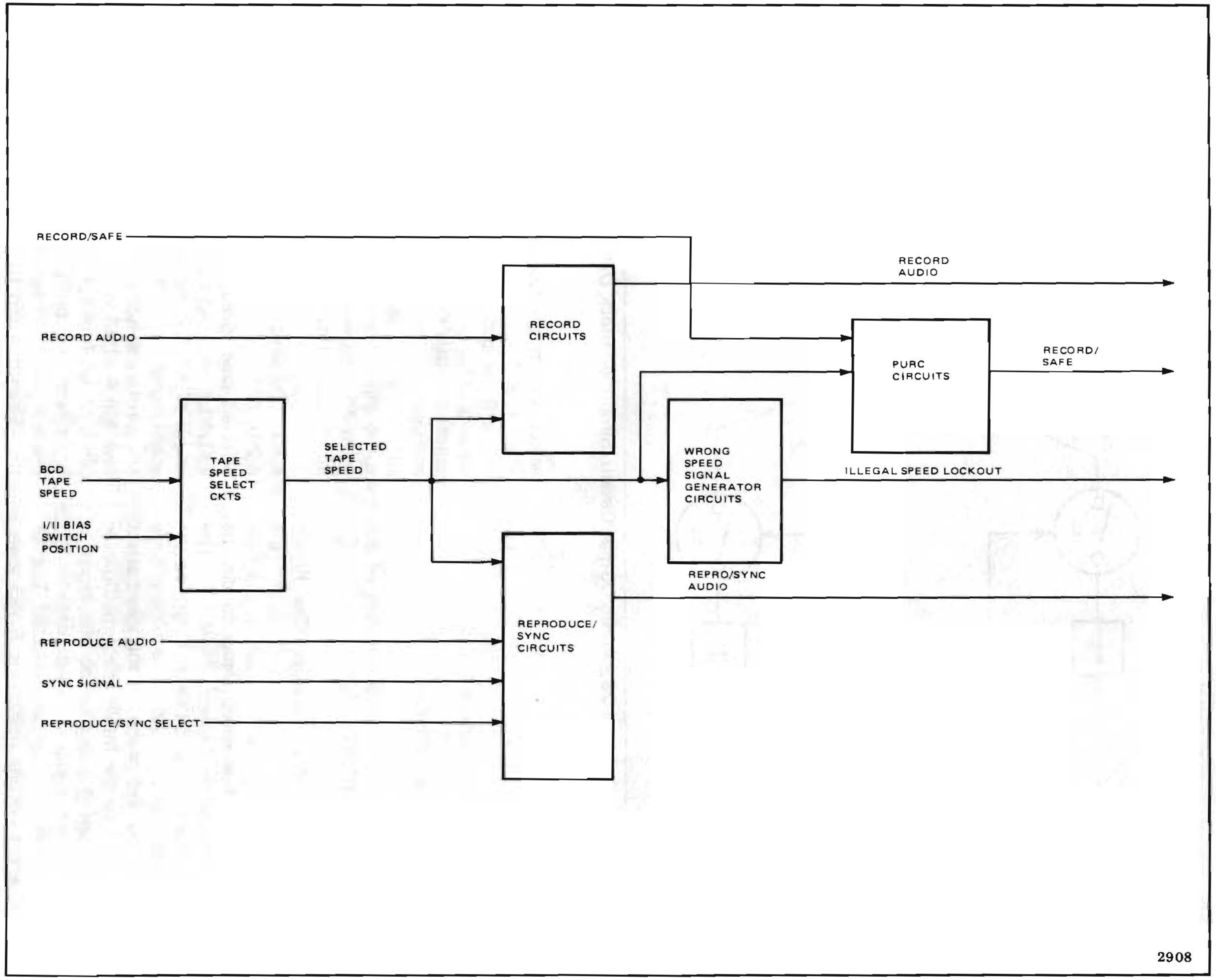



Figure 4-24. 4-Speed Dual Speed PADNET, Simplified Block Diagram

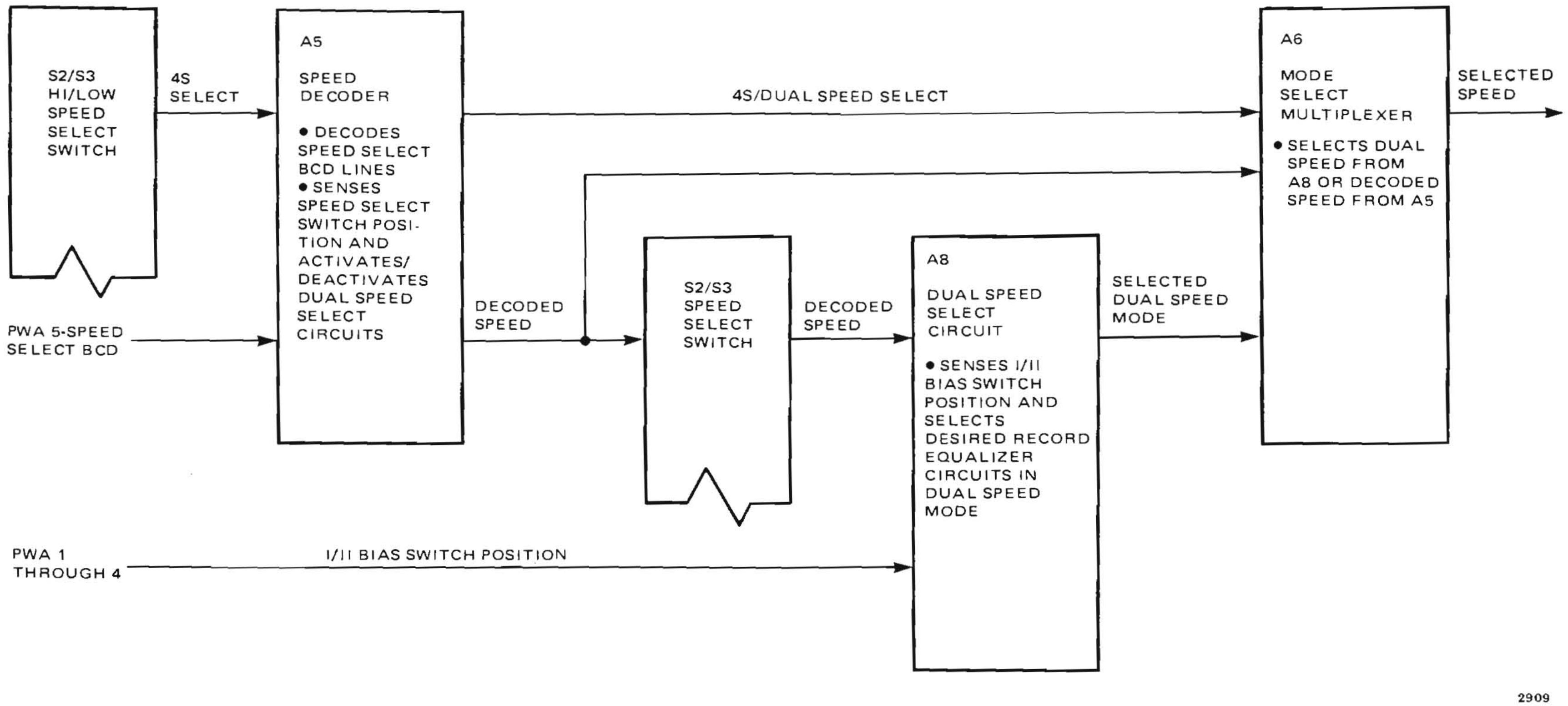



Figure 4-25. 4-Speed PADNET Tape Speed Circuits, Simplified Block Diagram

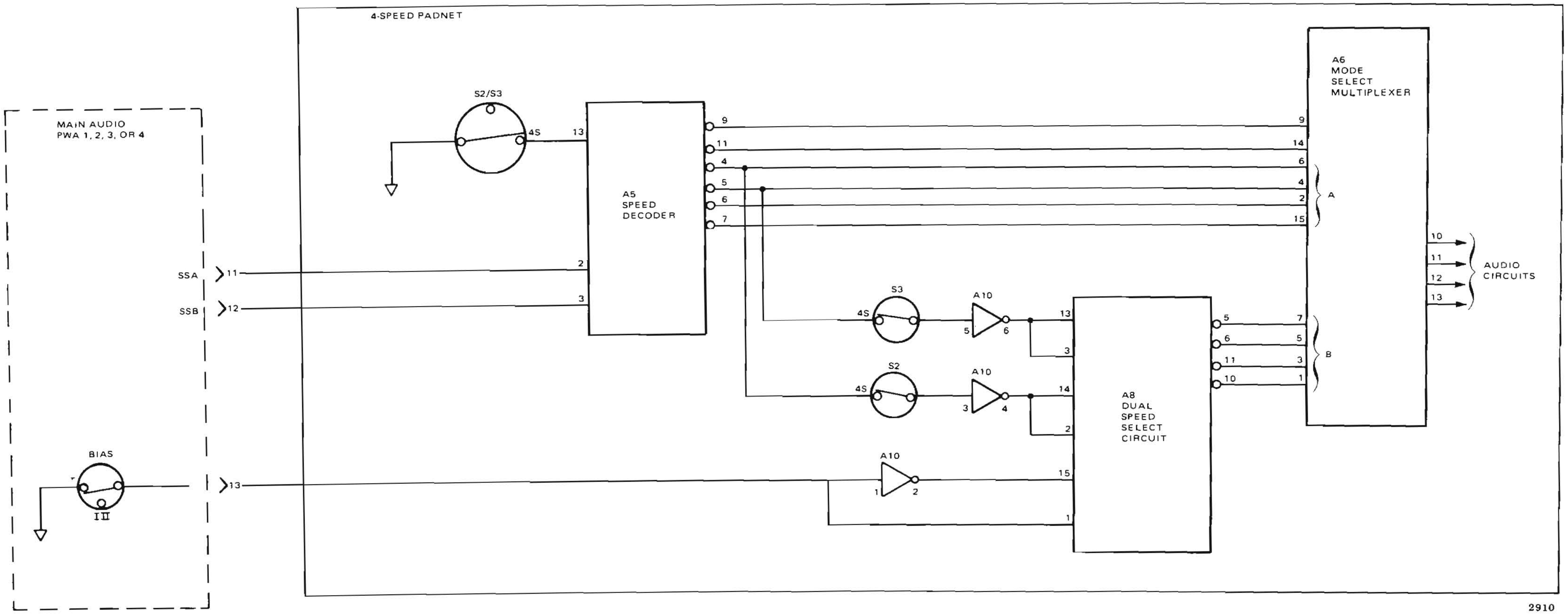



Figure 4-26. 4-Speed PADNET
Tape Speed Select Circuits,
Simplified Block Diagram

A5 goes high. This high is felt on pin 9 of A6 enabling the "A" portion of A6. The low on pin 6 of A6 is felt on pin 10 of A6 enabling the 30 in/s tape speed circuits within the PADNET. With 4S selected on S2 or S3 any tape speed selected on the speed select rotary switch will enable similar logic within the tape speed select circuits. With 30 in/s selected on the speed select rotary switch, pin 4 of A5 will go low. When the speed select switch S2 (high) is positioned to 30/15 in/s, pin 13 of A5 goes high and pin 11 will go high. This high is felt on pin 14 of A6, enabling the B portion of A6. The low on pin 9 of A6 disables the A portion of the multiplexer. The low on pin 4 of A5 is coupled through S2 and inverted by A10-4 and impressed on pins 14 and 2 of A8. With the speed select switch S3 (low) positioned to the 7.5/3.75 in/s, the high on pin 7 of A5 is coupled through S3, inverted by A10-6, and the low is impressed on pins 13 and 3. With the bias switch on the audio board in the I position, pin 1 of A8 goes low, enabling the A side of the output of A8. Pin 5 of A8 goes low and is impressed on pin 7 of A6. Pin 13 of A5 is high making pin 11 of A5 high and this high is impressed on pin 14 of A6, enabling the "B" side of the multiplexer. The low on pin 7 of A6 is impressed on pin 10 of A6, activating the appropriate tape speed circuits. With the bias switch on the audio board in II position, a high is inverted by A10-2 and a low impressed on pin 15 of A8. This low enables the B side of the output. Pin 11 of A8 goes low and is impressed on pin 3 of A6. With the B side of A6 enabled, the low on pin 3 of A6 is coupled to pin 12 of A6, thereby actuating the appropriate tape speed circuits.

**4-81. Reproduce/Synchronization Circuits (See Figure 4-27).** The repro/sync select signal, which originates from the control box, will allow either the reproduce audio or the synchronized audio to be routed to the reproduce/sync gain circuits. The appropriate speed selected repro gain network is energized by the selected speed signal and the repro/sync signal is routed to the hi/low frequency equalization circuits. The appropriate frequency equalization network is selected again by the selected speed signal. The output is routed to the Audio PWA.

When REPRO is selected, the repro/sync select signal goes low on pin 14 of the PADNET (see Figure 4-28). This signal is inverted and delayed by A10-8, 10, 12 and R75 then routed to pin 6 of the Repro/Sync Select switch A2. The repro signal enters the PADNET on pin B and is coupled through A2. The repro signal path from pin 2 of A2 is selected by the tape speed select circuits. When 4S is selected on the PADNET and 30 in/s selected on the speed-select rotary switch on the tape transport, the signal on pin 2 is routed through REPRO GAIN control R26 and through FET

**A5 Speed Decoder Truth Table**

| INPUT | | | OUTPUT |
|---|---|---|---|
| TAPE SPEED | SSA PIN 2 | SSB PIN 3 | LOGIC LOW PIN[1] |
| 30 | 0 | 0 | 4 |
| 15 | 1 | 0 | 5 |
| 7.5 | 0 | 1 | 6 |
| 3.25 | 1 | 1 | 7 |

[1] Indicates other three pins will be high.

Notes:

0 = low
1 = high

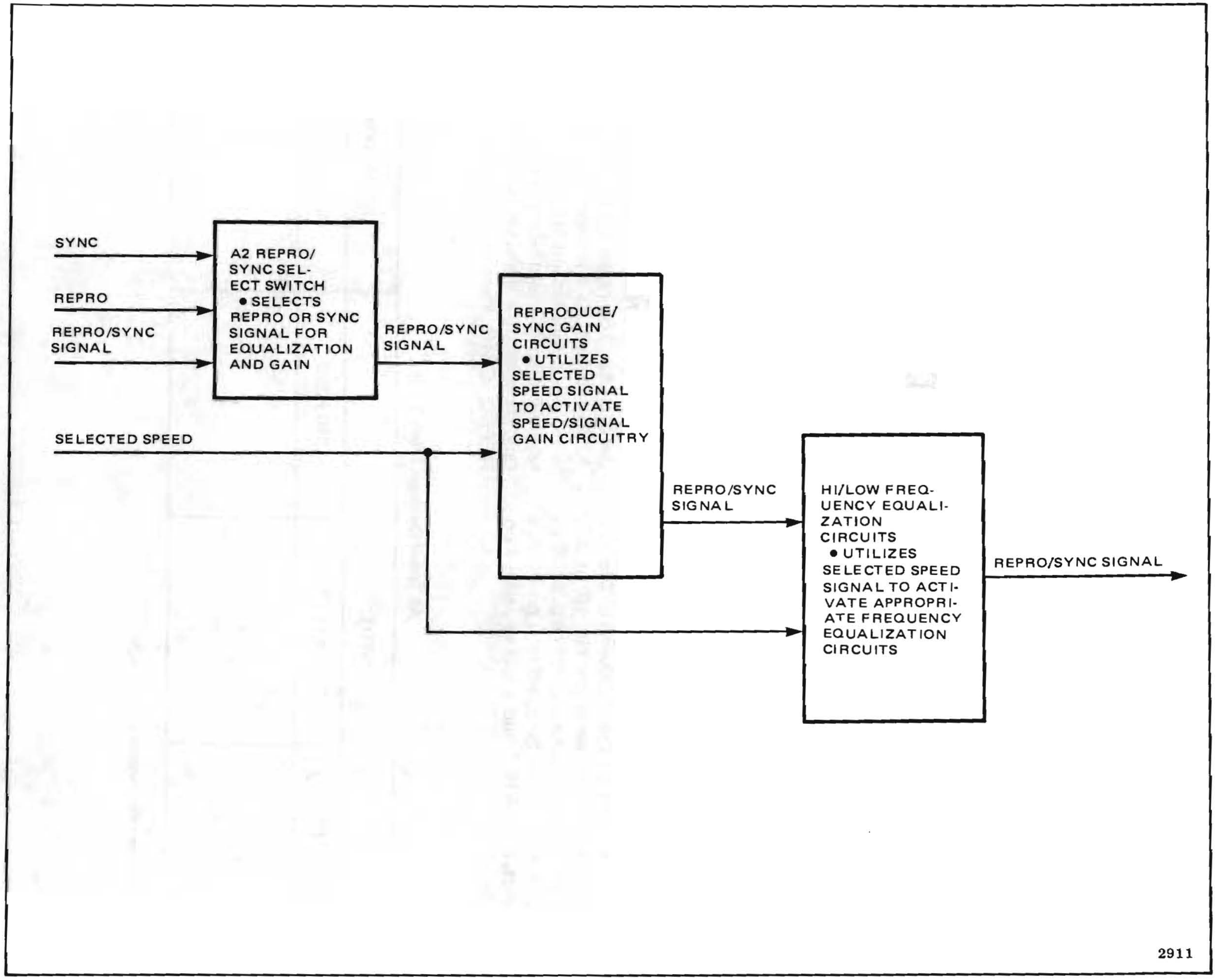



**Figure 4-27. Repro/Sync Circuits, Simplified Block Diagram**

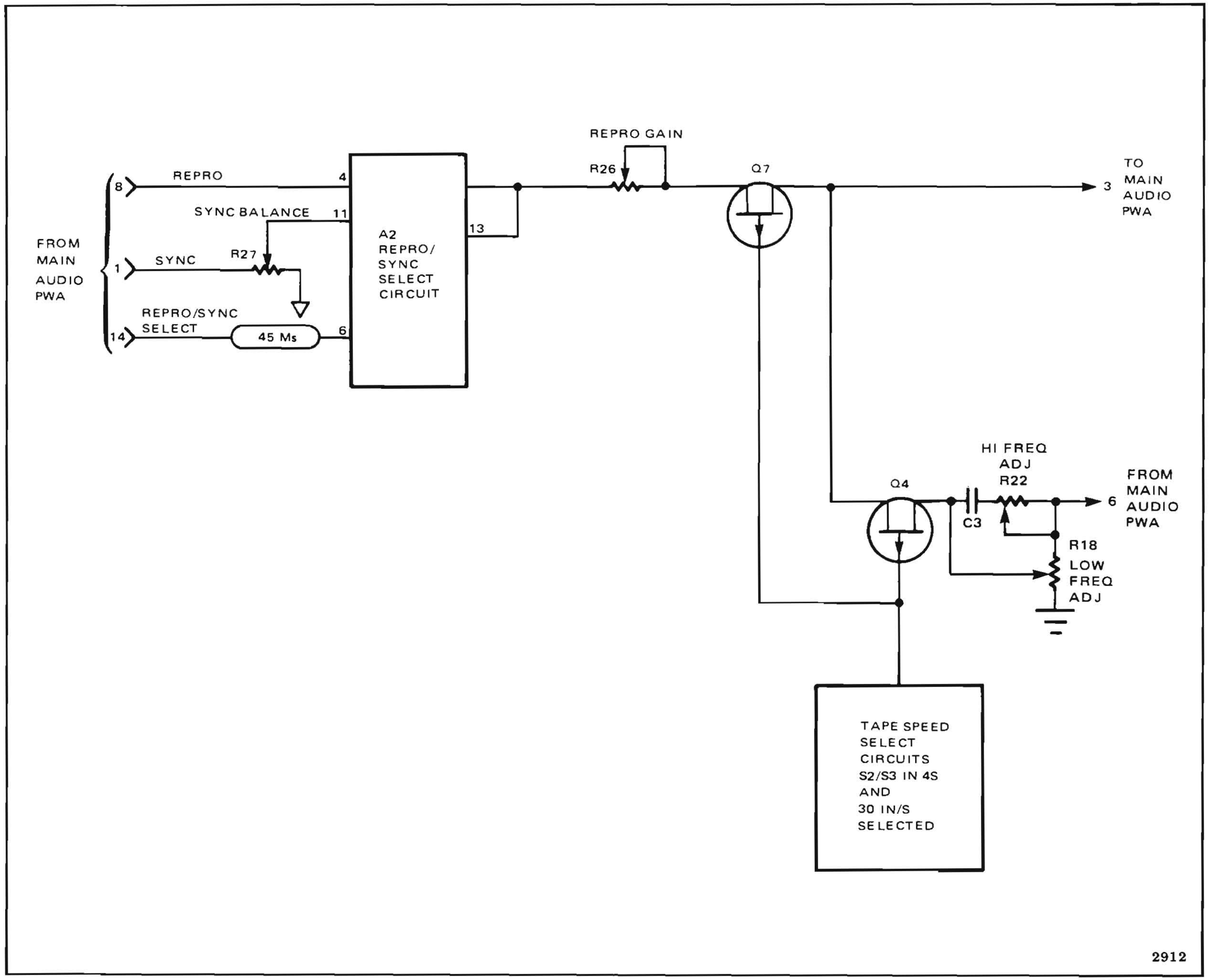



**Figure 4-28. Repro/Sync Circuits, Simplified Schematic**

switch Q7. The signal splits after Q7 with a portion going to pin 3 of the PADNET and a portion going to FET switch Q4. After leaving Q4, the repro signal is routed through FREQ ADJ controls R22 and R18 and then out of the PADNET on pin 6 to the main audio board. The sync signal enters the PADNET on pin 1 and is routed to SYNC BALANCE control R27. The high from R27 enters repro/sync select switch A2 on pin 11 and when pin 6 is low (SYNC is selected) the sync signal leaves A2 on pin 13. The sync signal then follows the same path as the repro signal.

**4-82. Record Circuits (See Figure 4-29).** The record circuit consists of six major blocks. The equalizing, shelving, and gain circuits are located on the PADNET along with the low frequency boost circuit, while the two amplifiers are located on the main audio board. Each circuit on the PADNET has four similar networks. One network will be operational when the operator selects the desired tape speed.

**4-83. Detailed Circuit Discussion (See Figure 4-30).** The record audio input signal enters the PADNET on pin P and is split into three paths. The first path is via R39 to the summing mode (pin 2 of A6 on the Main Audio PWA). The second path is to input network R41/C6 of the active differentiator (A5 on the Main Audio PWA). The third path is to the summing of A6-6 via R9/C10/Q16 with alternate paths selected by FET switches Q17, Q18, and Q19, depending upon the selected tape speed.

The output from the active differentiator A5-6 will, for a constant amplitude signal, rise 6 dB per octave with increasing frequency. Time constant components C6/R41 limit the maximum frequency of the rise. This output signal is then applied to RECord EQUalizing potentiometer R52, which is the main high-frequency equalizer control for 30 in/s tape speed. The setting of the equalizer control determines how much of the differentiated signal is summed with the direct signal, via R39 and applied to the summing mode A6-6. The equalized audio at A6-6 is routed to R48, RECord gain, through Q12 and out of the PADNET on pin 23.

In parallel with A6 is NAB low-frequency boost capacitor C7. When IEC standard is desired,

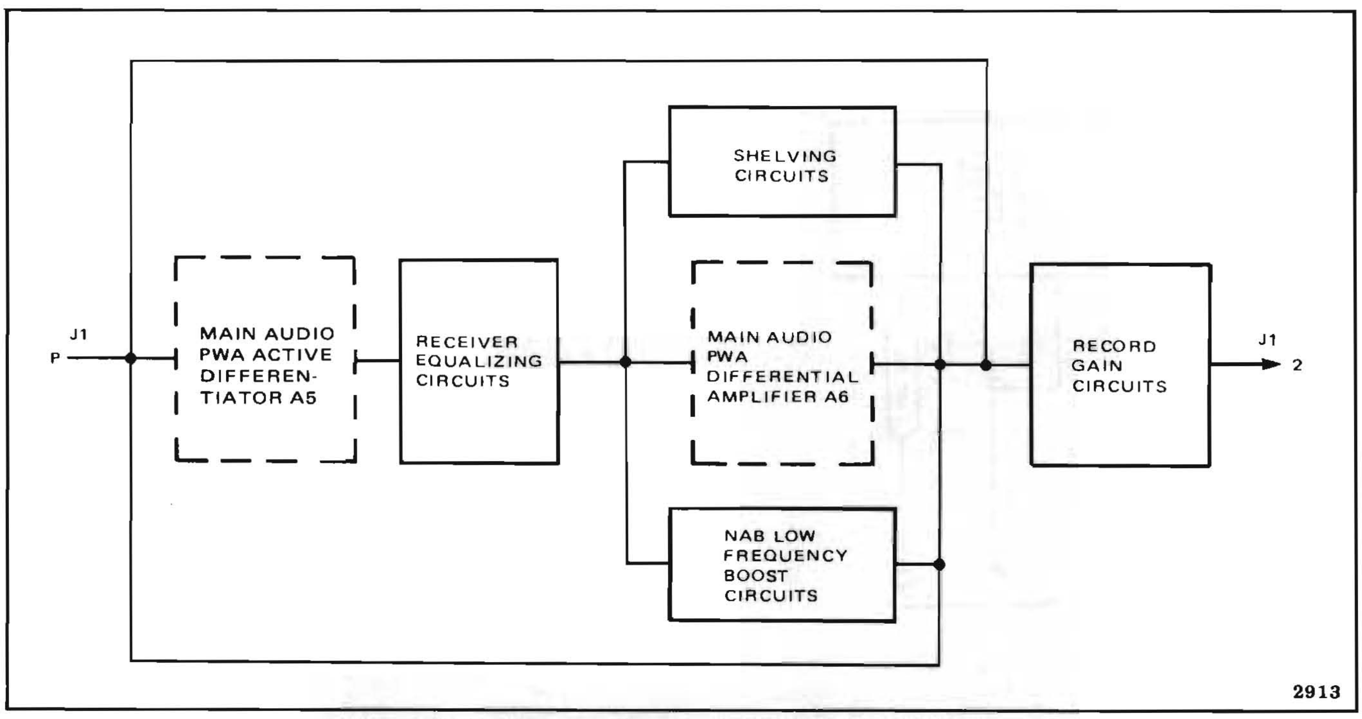



**Figure 4-29. Record Circuits Simplified Block Diagram**

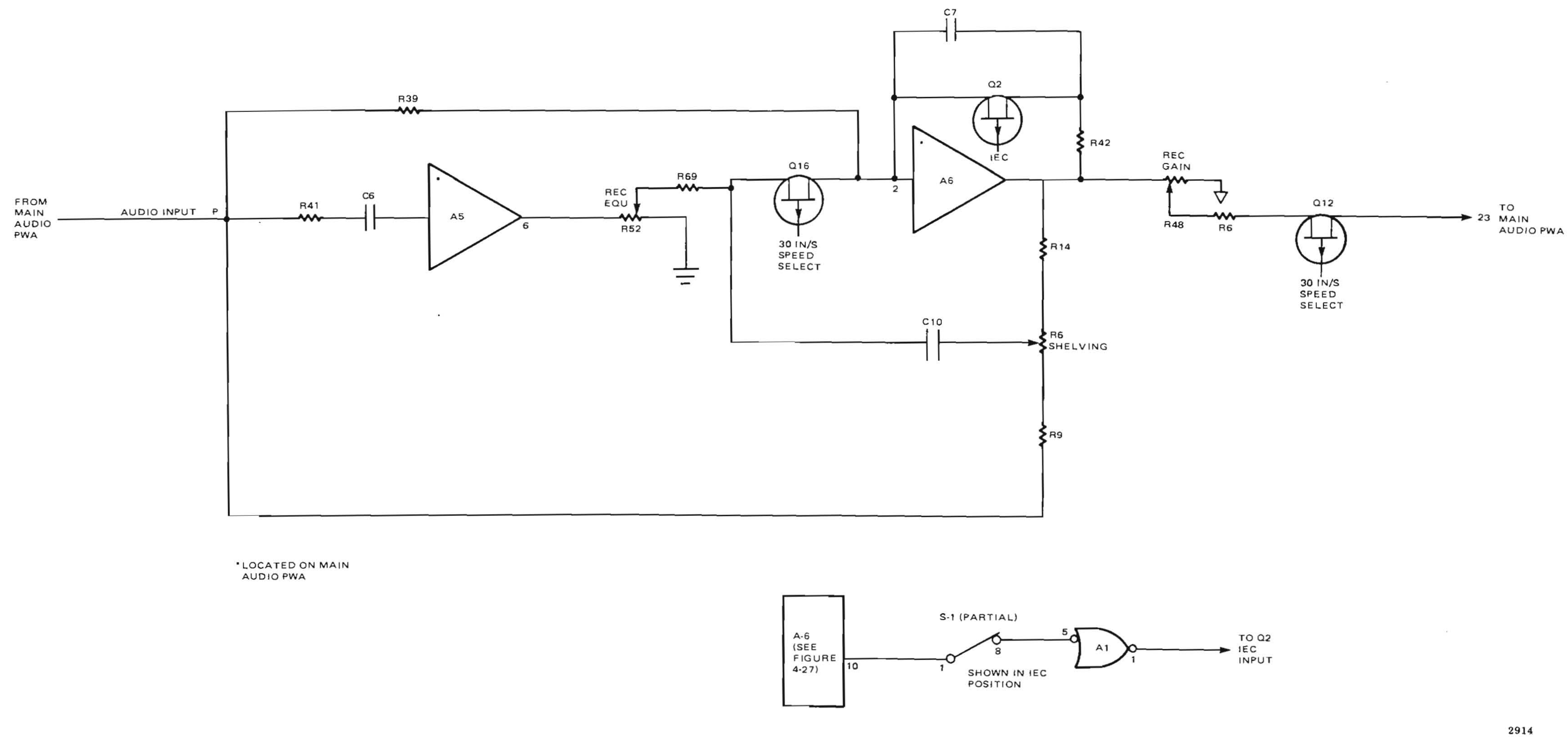



Figure 4-30. Simplified Schematic Record Circuits 30 in/s Tape Speed 4S Only

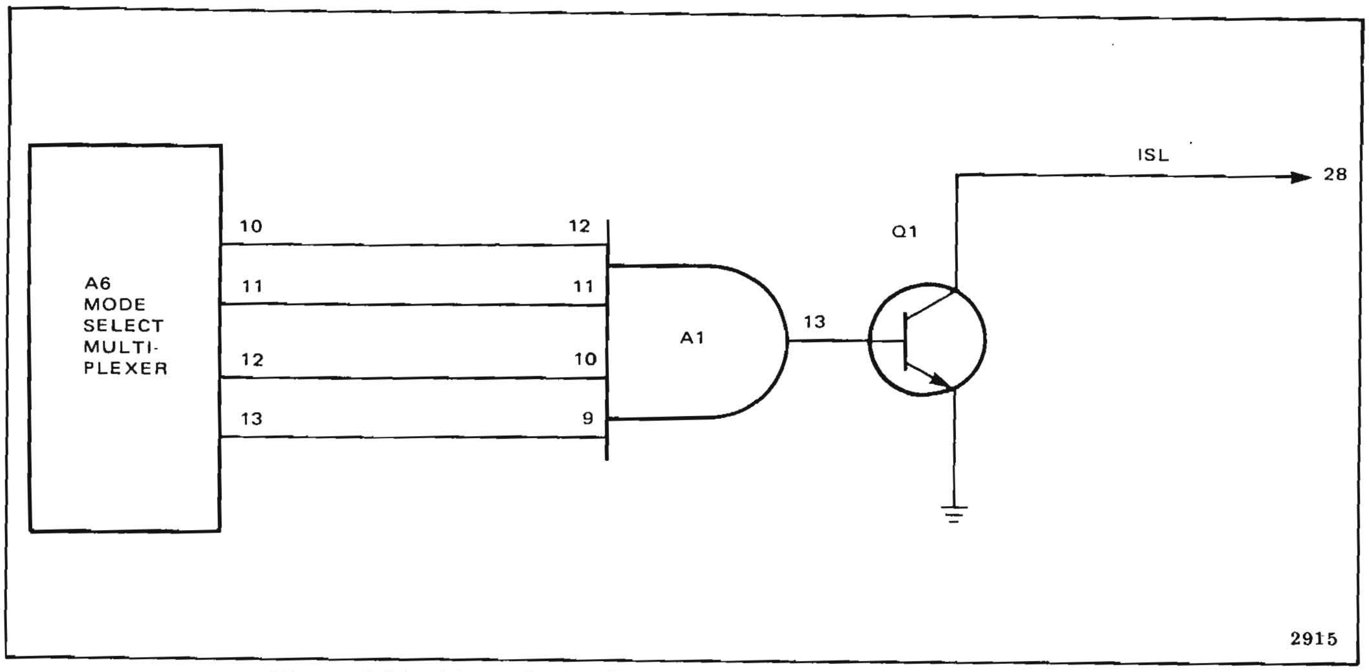



Figure 4-31. Illegal Speed Signal Generator, Simplified Schematic

capacitor C7 is shorted out by FET switch Q2. When 4S is selected and the 30 in/s is activated, the low on pin 1 of S1 is felt on pin 8 when the first portion of S1 is in the ON position. This low is routed to OR gate A1. The low on pin 1 of A1 activates FET switch Q2 shorting out C7. The path, for any other tape speed with the appropriate portion of S1 closed, will be similar.

**4-84. Illegal Speed Signal Generator (See Figure 4-31).** An illegal speed signal (ISL) is generated when a speed is selected on the speed select rotary switch that the S2/S3 speed select switches on the PADNET are not configured to accommodate or if S2 and S3 are both set for the same speed.

When an illegal speed is selected all the outputs of mode select multiplexer A6 go high, enabling AND gate A1. The high on pin 13 of A1 turns Q1 on and the ground on the emitter of Q1 is routed to pin 28 of the PADNET. When S2 or S3 on the PADNET is in the 4S position, a wrong speed signal cannot be generated.

**4-85. Bias Normalizing and Filtering Circuits (See drawing No. 4840468).** The 432-kHz bias signal enters the PADNET on pin FF where it is routed to the bias normalizing and filtering circuits. Bias normalizing resistor R1/R2 provides level setting of the received 432 kHz from the master bias bus via BIAS NORM potentiometer R1. The level normalized bias signal is then filtered by bandpass filter L1/C1 on the PADNET. The bias signal is then routed to pin 26 on the PADNET and pin 26 on the main audio boards.

**4-86. Input/Output Assembly**

Up to two input/output modules may be mounted side-by-side in an input/output assembly. One module is required for each audio channel, and each module contains a line input and a line output transformer that permits balanced line operation, a line driver, switchable peak/vu level meter, and input and output level controls with preset/manual switch controls. Figure 4-32 is a simplified block diagram of the input/output assembly, drawing 4840427 is the schematic of the input/output mainframe assembly, and drawing 4840421 is the schematic of the input/output module (schematics are in Section 6 of this manual).

**4-87. Line Input Amplifier.** The audio line input signal to be recorded is applied to the input of

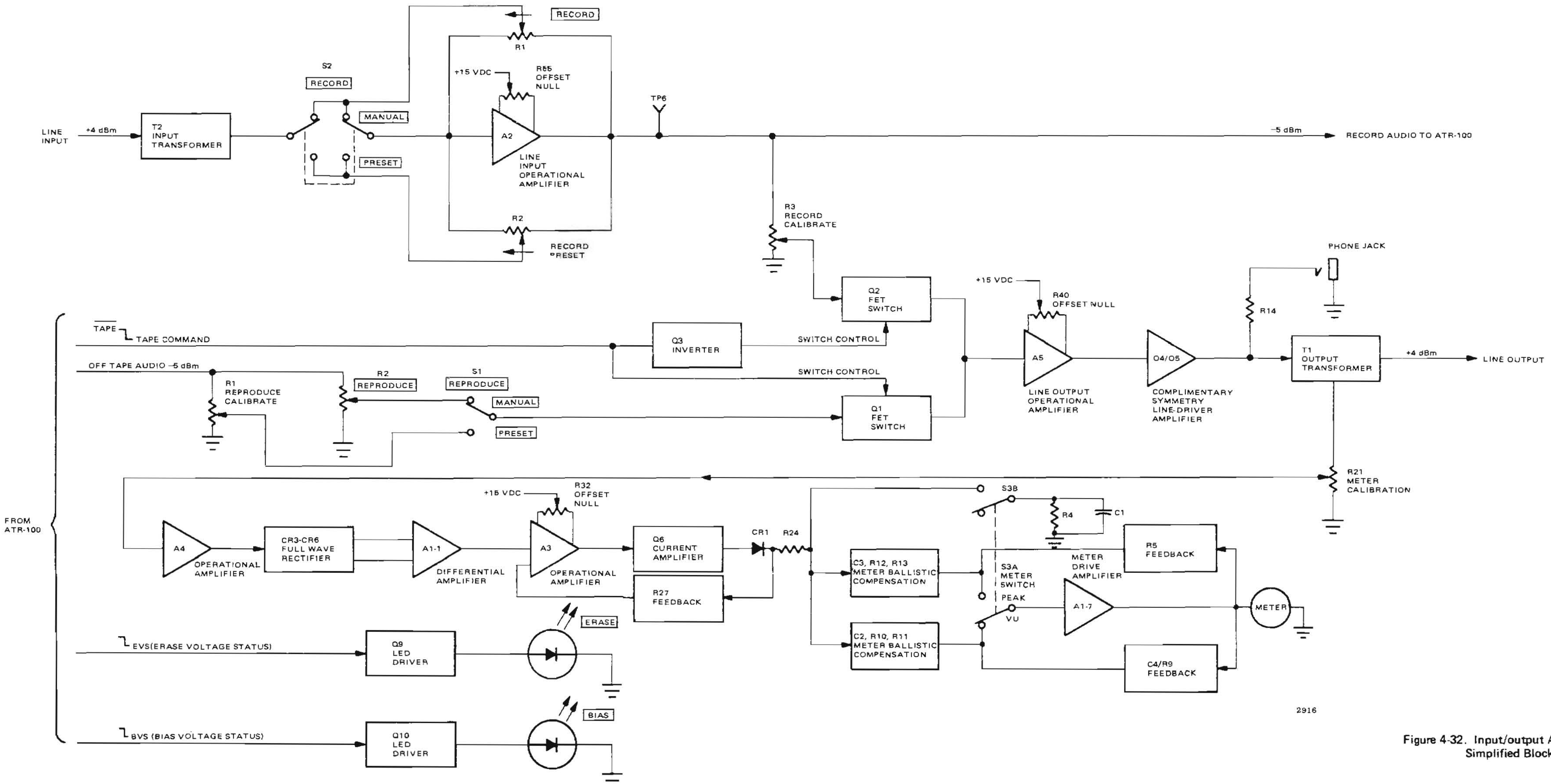



Figure 4-32. Input/output Assembly, Simplified Block Diagram

the input/output assembly. This signal can be either balanced or unbalanced (see Installation section), and the signal is fed through input transformer T2 to RECORD MANUAL/PRESET switch S2. In the PRESET position, the gain of line input operational amplifier is adjusted by record preset potentiometer R2 to provide a -5 dBm output level to the ATR-100 when the input is +4 dBm (or other input level is selected by the user).

If other than a predetermined input line level is fed to the input, switch S2 is placed in the MANUAL positon and the RECORD potentiometer control is used to control the gain of the amplifier A2 to provide a -5 dBm output operating level to the ATR-100. If required, the gain of amplifier A2 may be increased +6 dB by installing a jumper across series resistors R60 and R63 and changing C20 to 47 pF. (This also changes the input impedance from 50K to 25K ohms.) Offset null control R55 is adjusted so there is zero change in dc voltage when the RECORD potentiometer control is rotated through its range.

**4-88. Input Signal Monitoring.** In input monitoring mode, the line input signal can be monitored on the level meter and on the line-output line. The line input is sampled at the output of amplifier A2 and is fed through record calibrate potentiometer R3 to the input of FET switch Q2. In input monitoring mode, the $\overline{\text{tape}}$/tape command from the ATR-100 is high ($\overline{\text{tape}}$). This high turns FET switch Q1 off and the high is inverted by Q3. The low from the collector of Q3 turns FET switch Q2 on and the line input signal is fed to the line output amplifier. The output amplifier is formed from operational amplifier A5-6 and complementary symmetry line-driver transistors Q4 and Q5 which feed line output transformer T1. The gain of the output amplifier is set by two feedback loops. The first feedback loop is from the output of Q4/Q5 via R23/C6; and the second feedback loop is derived from a tertiary winding on output transformer T1, which supplies approximately 8 dB of additional feedback, via R22/C5 to the summing node of A5-2. The output signal can be either balanced or unbalanced (see *Installation* section of manual).

Record calibrate potentiometer R3 is adjusted so that the -5-dBm level at the output of amplifier A2 is amplified to provide a +4-dBm line-output level (or other output level as selected by the user). Offset null control R40 is adjusted so there is zero volts at TP2 when no input signal is applied to the input/output assembly.

**4-89. Reproduce Mode.** In reproduce mode, the reproduced audio signal at a -5-dBm level from the ATR-100 is applied to the REPRODUCE control and the reproduce preset control R1. Control R1 is adjusted so that when REPRODUCE switch S1 is in the PRESET position, the output line level will be +4 dBm (or other output level as selected by the user). For manual adjustment of output line level, switch S1 is placed in the MANUAL position and the REPRODUCE potentiometer control is adjusted for the desired line-output level. In reproduce mode, the $\overline{\text{tape}}$/tape command from the ATR-100 is low (tape). This low enables FET switch Q1 and, via inverter Q3, disables FET switch Q2. When Q1 is enabled, the audio signal from the ATR-100 is applied to the input of operational amplifier A5.

**4-90. Meter Circuit Operation.** The signal to be displayed on the meter is sampled from the tertiary feedback winding on output transformer T1. This signal is applied to meter calibration potentiometer control R21, which is set so that a +4-dBm line output signal (or other level selected by the user) will indicate 0 vu on the level meter when the peak/vu switch S3 is in the vu position. (In the peak position the meter will read -6 when R21 has been set to read 0 vu in vu position.) The signal at the wiper of R21 is applied to the noninverting input of operational amplifier A4. This amplifier has its output connected to the full-wave bridge rectifier formed by CR3-CR6. Current feedback from the lower side of the bridge (junction of CR5/CR6) is applied to the inverting input of A4-6. This feedback linearizes the diode transfer characteristics to produce a precision full-wave rectifier. Components R19/C9/C10 set the ac gain of the circuit in conjunction with resistor R30.

The rectified output of the diode bridge appears across R30 and is applied to the differential inputs of A1-1. The output of A1-1 is a full-wave rectified signal referred to ground level. This signal is fed to amplifier A3-1, which uses Q6 as an output current amplifier. Amplifier A3-1 and Q6 provide a high

drive current stage which is required when charging the peak mode holding capacitor C1. Time constant components C1/R24 determine peak mode integration time and time constant components C1/R4 predominantly determine the fallback time.

In peak mode, switch S3A connects the input and feedback network R5/R12/R13/C3 around meter drive amplifier A1-7. In vu mode, switch S3B disconnects the integration capacitor C1, and switch S3A connects the other input/feedback network R10/R11/C2 and R9/C4 around meter drive amplifier A1-7. These switched networks provide the necessary gain change for peak and vu metering in addition to providing the correct meter ballistic for both modes.

Offset null control R32 is adjusted so that the level meter will show no deflection (same reading as when power is removed and meter needle is at extreme left-hand dial position) when no signal is applied to the input/output assembly.

**4-91. Erase and Bias Voltage Confidence Indicators.** The ERASE and BIAS LED indicators illuminate when the ATR-100 is in the record mode. In record mode, the EVS (erase voltage status) and BVS (bias voltage status) commands are low. These commands cause Q9 and Q10 to conduct, which causes the LED indicators to illuminate.

**4-92. ±15-Vdc Regulator.** A ±15-Vdc zener diode regulator is used to power the input/output module assembly. Power in the form of ±24 Vdc is furnished from the ATR-100 and is applied to series-pass transistors Q7 and Q8, which are connected as emitter followers. The output voltage at the emitters of Q7 and Q8 is determined by zener diodes VR1 and VR2, which are connected between the base and ground of Q7 and Q8, respectively.

### 4-93. Tape Timer Functional Description

The tape timer displays in hours, minutes, and seconds the elapsed time that the tape has moved at the selected speed from a zero reference established by pressing the RESET pushbutton switch on the control unit. The tape timer contains a counter and associated arithmetic logic to detect the relative tape position and provide a time-multiplexed, binary-coded decimal (BCD) output for the display of the tape position in hours, minutes, and seconds of play/record time at the selected tape speed. The tape timer receives a tape direction signal from the control unit, a selected speed signal from the tape transport, and pulses from a tape-driven tachometer (tach) on the tape transport. The tape timer counts the number of tach pulses received, converts the length of tape represented by the tach pulses to record/play time at the selected speed, and adds or subtracts the time represented by the tape motion from the current time being displayed, depending on the direction of tape motion. The tape timer sends five binary-coded decimal digits to the display on the control unit. To minimize the number of interconnecting leads between the tape timer and the control unit, the five digits are transmitted serially over a common 4-bit bus to a BCD-to-7 segment decoder in the control unit. The output of the BCD-to-7 segment decoder is sent in parallel to five 7-segment display indicators that comprise the 5-digit display on the control unit. Five digit select lines are also sent to the control unit. The digit select lines identify the current digit being sent from the tape timer and enable the corresponding one of five 7-segment display indicators.

### 4-94. Tape Timer Circuit Details

The tape timer circuitry is principally located on Transport Control PWA 7. The display and ancillary BCD-to-7-segment encoder are located on the control unit. Figure 4-33 is a simplified block diagram of the tape timer, and drawings 4840397 and 4840396 are the schematic diagrams, respectively.

**4-95. Tape Timer Display.** The tape timer display is contained on the control unit assembly and consists of five 7-segment light emitting diode (LED) display indicators (A1 through A5 on Control Unit PWA 1), five driver transistors (Q1 through Q5 on PWA 1), and a BCD-to-7-segment encoder (A3 on PWA 2). The serial stream of binary-coded decimal digits from the tape timer logic on PWA 7 are sent to the BCD-to-7-segment decoder A3 located on the control unit PWA 2. The binary-coded decimal digits are sent via 4

lines: BCD-A, BCD-B, BCD-C, BCD-D. The BCD-to-7-segment decoder A3 provides a logic low (ground) to the segments required to form the digit, which is sent in BCD via BCD-A through BCD-D, on the display.

The seven lines that comprise the output of the BCD-to-7-segment decoder A3 are sent to the Control Unit PWA 1, where they are connected in parallel to each of the corresponding segments on the five 7-segment displays, A1 through A5. Each of the five 7-segment displays consists of seven light-emitting diodes with common anodes. Selection of the 7-segment pattern corresponding to the digit sent via the BCD-A through BCD-D is accomplished by applying a positive 5 volts (logic high) to the anode of the selected 7-segment display and keeping the anodes of the other 7-segment displays at ground (logic low). The digit selection signals DS-1 through DS-5 from the tape timer circuits on Transport Logic PWA 7, via transistor switches, provide a positive 5 volts to the anode of 7-segment display A1 through A5, respectively. When a digit select line goes low (0 Vdc), the associated transistor switch conducts and provides a positive 5 volts to the anode of the corresponding 7-segment display. Since only one digit select line goes low at a time, the remaining transistor switches are not conducting, and the remaining anodes of the unselected 7-segment displays remain at 0 Vdc. Therefore, only the selected digit is lit.

**4-96. Tape Timer Tachometer.** The tape timer tachometer is contained on the tape transport assembly and consists of the tape wheel assembly and associated electro-optical switching assembly. The tape wheel assembly is mechanically coupled to the tape to provide one complete rotation of the tape wheel for each 7.5 inches of tape motion. The tape wheel assembly contains a shutter which interrupts the optical path of the electro-optical switch at a rate of 20 times per revolution. The electro-optical switch provides TTL-level pulses to buffer Q3-Q5 on Transport Control PWA 7. Buffer Q3-Q5 provides pulse shaping to improve the rise and fall times of the pulses received from the electro-optical switch. The buffered tachometer (tach) pulses are then sent to the tach pulse synchronizer A33-10/A33-15 that consists of two D-type latches that are clocked by the positive-going edge of the 432-kHz system clock. The tach pulse synchronizer A33-10/A33-15 retimes the tach pulses to provide a single negative-going pulse one clock period wide for each tach pulse received, regardless of the length of the tach pulse.

When the output of the buffer Q3-Q5 goes positive, latch A33-10 is set by the positive-going edge of the 432-kHz clock. The output of latch A33-10 goes to latch A33-15 and NAND gate A27-11. Latch A33-15 is set to the same state as latch A33-10 by the next positive-going edge of the 432-kHz clock. The output of latch A33-10 is combined with the complement of latch A33-15 by NAND gate A27-11 so that during the interval that latch A33-10 is first set and the time that latch A33-15 is set, one clock interval later, the output of NAND gate A27-11 goes low. During all other conditions, NAND gate A27-11 remains high. The output of NAND gate A27-11 goes to tach pulse latch A27/A21. Tach pulse latch A27/A21 is an RS-type flip-flop, which stores the received synchronous tach pulse until required by the arithmetic logic of the tape timer.

**4-97. Tape Timer Arithmetic Logic.** The tape timer arithmetic logic is contained on Transport Control PWA 7. The tape timer arithmetic logic consists of an up/down counter and associated control and timing logic. The up/down counter is an 8-digit serial binary adder that circulates data through a 4-bit parallel adder serially by digit. The up/down counter provides the incrementing and decrementing of time in hours, minutes, and seconds and division of the tach pulse rate according to the selected operating speed. An 8-bit ring counter identifies the digit currently at the output of the 8-digit, 4-bit, serial binary adder and provides the control for multiplexing the digits from the adder at the control unit display. The operations within the tape timer arithmetic logic are synchronized by the 432-kHz clock. Table 4-8 shows the format for the eight 4-bit digits contained in the four 8-bit shift registers and the time interval during which each of the 4 bits representing a single digit are available at the output of the register.

As shown in Table 4-8, the first time period ($t_0$) contains a digit whose modulus varies with the tape

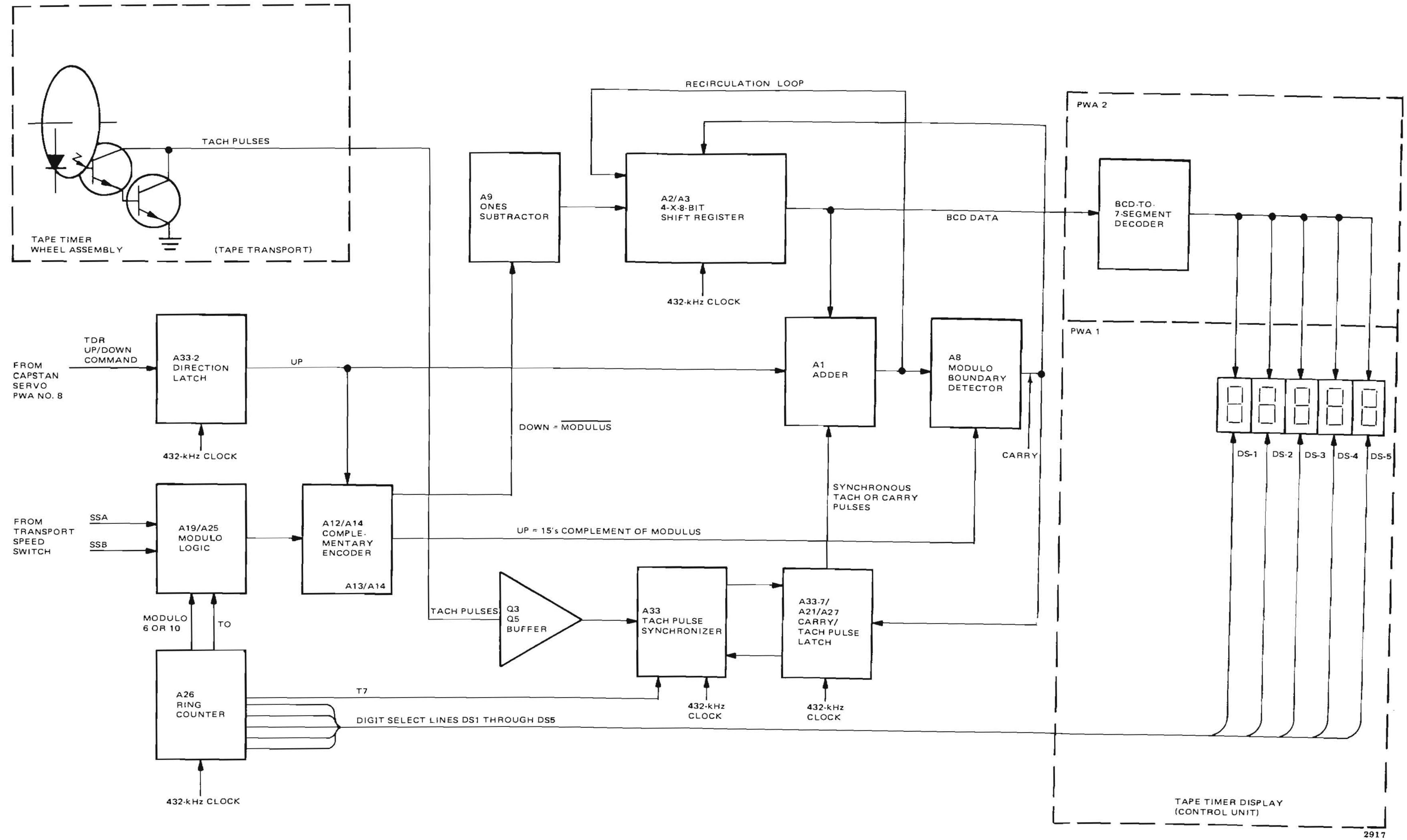



**Figure 4-33. Tape Timer, Simplified Block Diagram**

Table 4-8. Counter Data Word Format

| MODULO | TIME |
|---|---|
| Tape-Speed Divider (modulo depends on tape speed selected) | $t_0$ |
| Tenths of Seconds (modulo 10) | $t_1$ |
| Units of Seconds (modulo 10) | $t_2$ |
| Tens of Seconds (modulo 6) | $t_3$ |
| Units of Minutes (modulo 10) | $t_4$ |
| Tens of Minutes (modulo 6) | $t_5$ |
| Units of Hours (modulo 10) | $t_6$ |
| Tens of Hours (modulo 10) | $t_7$ |

speed. Since the tach pulses are generated at a rate of 20 times per 7.5 inches of tape, the modulus of the digit at time $t_0$ varies with the tape speed selected to divide the tach pulses by a factor which provides 10 pulses per second at the selected operating speed. At a selected operating speed of 30, 15, 7.5, and 3.75 inches per second, the modulus of the digit at $t_0$ is 8, 4, 2, and 1, respectively. The digits at times $t_1$ through $t_7$ represent the operating time in hours, minutes, seconds, and tenths of a second at the selected operating time. Only five digits are displayed on the control unit.

The digits at time $t_1$ through $t_5$ or at time $t_2$ through $t_6$ may be selected by link strapping on the tape timer logic assembly to display tenths of a second, seconds, and minutes or to display seconds, minutes, and hours, respectively, on the control unit display. The output signals from the ring counter are strapped to the enable signal lines, DS-1 through DS-5, to select the appropriate digit on the control unit display.

The tape up/down counter in the tape timer logic consists of shift register A2/A3, adder A1, ones subtractor A9 modulo boundary detector A8, and carry flip-flop A33-7. The up/down counter shifts each digit in the counter data word in a 4-bit slice to the data output lines. If a tach pulse is not received by the tape timer logic within the previous cycle ($t_0$ through $t_7$), the data is recirculated through the up/down counter without being modified. If a tach pulse is received by the tape timer logic during the previous cycle ($t_0$ through $t_7$), the count in the up/down counter is incremented by one when the tape motion is in a forward direction, or decremented by one when the tape motion is in the reverse direction.

The timing and control logic of the tape timer consists of ring counter A26, direction latch A33-2, modulo logic A19/A25, complementary encoder A13/A14, and tach pulse latch A21/A27. Ring counter A26 is clocked by the positive-going edge of the 432-kHz signal and generates the 8-bit time intervals ($t_0$ to $t_7$) for one cycle of operation of the up/down counter. The modulo logic A19/A25 receives the speed selector signals, SSA and SSB, from the tape transport speed selector switch and timing information from the ring counter A26. The modulo logic generates the 15's complement of the modulus for each digit in the counter data word at the corresponding time interval. The modulo information, in 15's complement form, is sent to complementary encoder A13/A14. Complementary encoder A13/A14 provides the modulus or its complement to ones subtractor A9 or modulo boundary detector A8, respectively. Direction latch A33-2, which is set by the tape up/down command TDR, generates the control signal UP to complementary encoder A13/A14. The UP signal, if set (high), gates the complemented modulus to modulo boundary detector A8. If the UP signal is reset (low), the modulus is sent to subtractor A9. The UP signal is also sent to adder A1 where it provides the control signal to increment to decrement the counter when a tach pulse has been received.

The modulo information is sent to the complementary encoder A13/A14 which provides the modulus or its complement to the ones subtractor A9 or the modulo boundary detector A8, respectively. Tape direction latch A33-2, which is set by the tape up/down command (TDR), generates the control signal (UP) to the complementary encoder A13/A14. The UP signal, if set (high), gates the 4-bit complement of the modulus to modulo boundary detector A8. If the UP signal is reset (low), the modulus is sent to the ones subtractor A9 in BCD. The UP signal is also sent to adder A1 where it provides the control signal to increment or decrement the counter when a tach pulse has been received.

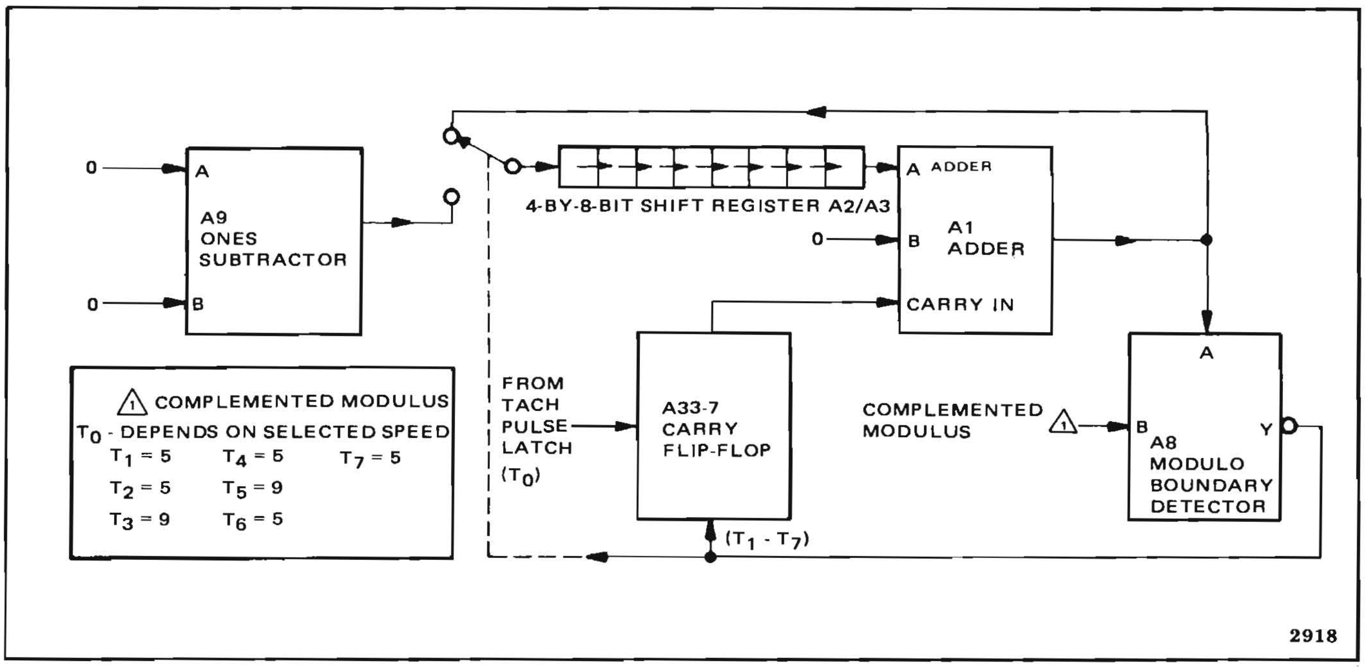



**Figure 4-34. Count Up Logic, Simplified Block Diagram**

4-98. **Initialization.** The tape timer is initialized by pressing and releasing the RESET pushbutton on the control unit. Pressing the RESET pushbutton generates a low CRB signal to the tape timer. When CRB is low, the tach and carry pulses from the carry flip-flop A33-7 are inhibited from going to the counter and the contents of 4-by-8-bit shift register A2/A3 are cleared. The tape timer is also initialized by the wakeup signal, which is generated when power is first applied to the unit, via a "wired-OR" that forces the CRB line to the tape timer logic low.

4-99. **Count-Up Mode.** When the tape is moving forward, the tape timer is in a count-up mode. During this time, the TDR signal (up/down command) is high. When the TDR signal is high, direction latch A33-2 is set by the positive-going edge of the 432-kHz clock. With direction latch A33-2 set, the output of the carry flip-flop A33-7 is directed to the carry input of adder A1 through NOR gate A20-1; the 4-bit data from the modulo logic is gated to modulo boundary detector A8 via the complementary encoder A13/A14; and the 4-bit data to the ones subtractor A9 is low. Figure 4-34 shows a simplified block diagram of the serial adder formed by 4-by-8-bit shift register A2/A3 and associated components A1, A8, and A9.

As shown in Figure 4-26, each BCD digit is shifted through the shift register and adders as a parallel 4-bit number. The data through 4-by-8-bit shift register A2/A3 is shifted serially by the 432-kHz signal. At time $t_0$, the least significant bit of the eight-digit BCD number is shifted out of the register to the A inputs of adder A1. During the count-up mode, the B inputs to adder A1 from NOR gate A20-13 are low, and the carry in to adder A1 will go high only when a tach pulse had been received during the previous $t_0$ through $t_7$ cycle, or a carry is generated at any other period than $t_7$. If no tach pulse was received during the previous cycle ($t_0$ through $t_7$), the least significant digit which is present at $t_0$ will be unchanged by adder A1. The output of adder A1 is recirculated back to the input of 4-by-8-bit shift register A2/A3. The output of the adder A1 is also sent to the A input of modulo boundary detector A8. The B input to modulo boundary detector A8 is the 15's complement of the modulus for that specific digit. At time $t_0$, the modulus is determined by the setting of the speed selector on the tape transport. The complemented modulus at the B input to

modulo boundary detector A8 during $t_0$ will be 7, 11, 13, and 14 for selected speeds of 30, 15, 7.5, and 3.75 inches per second, respectively.

The output of adder A8 goes to NAND gate A31-6, which provides a low (0 Vdc) signal to the data selection input of the shift register and, via NAND gate A27-6, to carry flip-flop A33-7. As long as no tach pulses are received by the tape timer logic, the count continues to be recirculated through the shift register unchanged and the output of NAND gate A31-6 remains high. When a tach pulse is received at the end of $t_7$, the carry flip-flop A33-7 is set, which generates an input to adder A1 during $t_0$. This input increments the least significant digit from the shift register. The incremented output of adder A1 is summed with the complemented modulus by modulo boundary detector A8. If the resulting sum does not equal 15, NAND gate A31-6 remains high. With NAND gate A31-6 high, the incremented digit is clocked back into the shift register at the start of $t_1$ and the carry flip-flop A33-7 is not set again. Therefore, the remaining digits at $t_1$ through $t_7$ will be recirculated unchanged through the shift register. If at the start of $t_0$, a tach pulse had been received and the resulting incremented output of adder A1 plus the complemented modulus equaled 15, the output of NAND gate A31-6 would go low. With the output of A31-6 low, the incremented digit is not recirculated back to the shift register. Instead the output of the ones subtractor A9 is selected. During count up, the output of ones subtractor A9 is always equal to 0.

In addition to selecting the output of ones subtractor A9 as the input of the shift register, the low output of NAND gate A31-6, via NAND gate A27-6, sets carry flip-flop A33-7 at the start of the next time interval ($t_1$). At $t_1$, the second least significant digit is shifted out to adder A1 and, if carry flip-flop A33-7 is set (least significant digit + complemented modulus = 15), the carry in to adder A1 is high and the second least significant bit will be incremented. The sum from adder A1 during time $t_1$ is added to the complemented (base 16) modulus by modulo boundary detector A8 and, if the sum equals 15, NAND gate A31-6 goes low. If NAND gate A31-6 goes low, zero is loaded into the shift register and the carry flip-flop A33-7 is set to provide a carry in to adder A1 at $t_2$. If the sum out of modulo boundary detector A8 did not equal 15, NAND gate A31-6 will remain high and the incremented sum out of adder A1 is recirculated back to the shift register. This process repeats during each successive bit time, $t_2$ through $t_6$. At $t_7$, the most significant digit is shifted out of 4-by-8-bit shift register A2/A3 to adder A1. The status of the carry flip-flop A33-7 is inhibited from generating a carry in to adder A1 by the $t_7$ timing pulse via buffer A37-12, which is "wire-ANDed" with the output of carry flip-flop A33-7 via buffer A37-10. Since during $t_7$ the most significant digit is never incremented, a carry is not generated into the least significant digit as a result of the most significant digit exceeding the modulus.

**4-100. Count-Down Mode.** When the tape is moving in a reverse direction, the tape timer is in a count-down mode. During this time, the TDR signal (up/down command) is low. When the TDR signal is low, direction latch A33-2 is reset by the positive-going edge of the 432-kHz signal. When direction latch A33-2 is reset, the output of carry flip-flop A33-7 is directed to the B inputs of adder A1 through NOR gate A20-13, the 4-bit data from the modulo logic is gated to ones subtractor A9 via complementary encoder A13/A14, and the 4-bit B input to modulo boundary detector A8 is low. Figure 4-27 shows a simplified block diagram of the serial adder formed by 4-by-8-bit shift register A2/A3 and associated logic components A1, A8, and A9.

As shown in Figure 4-35, each BCD digit is shifted through the shift register and logic as a parallel 4-bit number. The data through 4-by-8-bit shift register A2/A3 is shifted serially by the 432-kHz signal. At time $t_0$, the least significant digit of the eight-digit BCD number is shifted out of the register to the A inputs of adder A1. During the count-down mode, the carry in to adder A1 from NOR gate A20-1 is held low, and the 4-bit B inputs to adder A1 will go high when a tach pulse has been received during the previous $t_0$ through $t_7$ cycle or a carry is generated at any other period than at $t_7$. If no tach pulse is received during the previous cycle ($t_0$ through $t_7$), the least significant digit which is present at $t_0$ will be unchanged by adder A1. The output of adder A1 is recirculated back to the input of 4-by-8-bit shift register A2/A3.

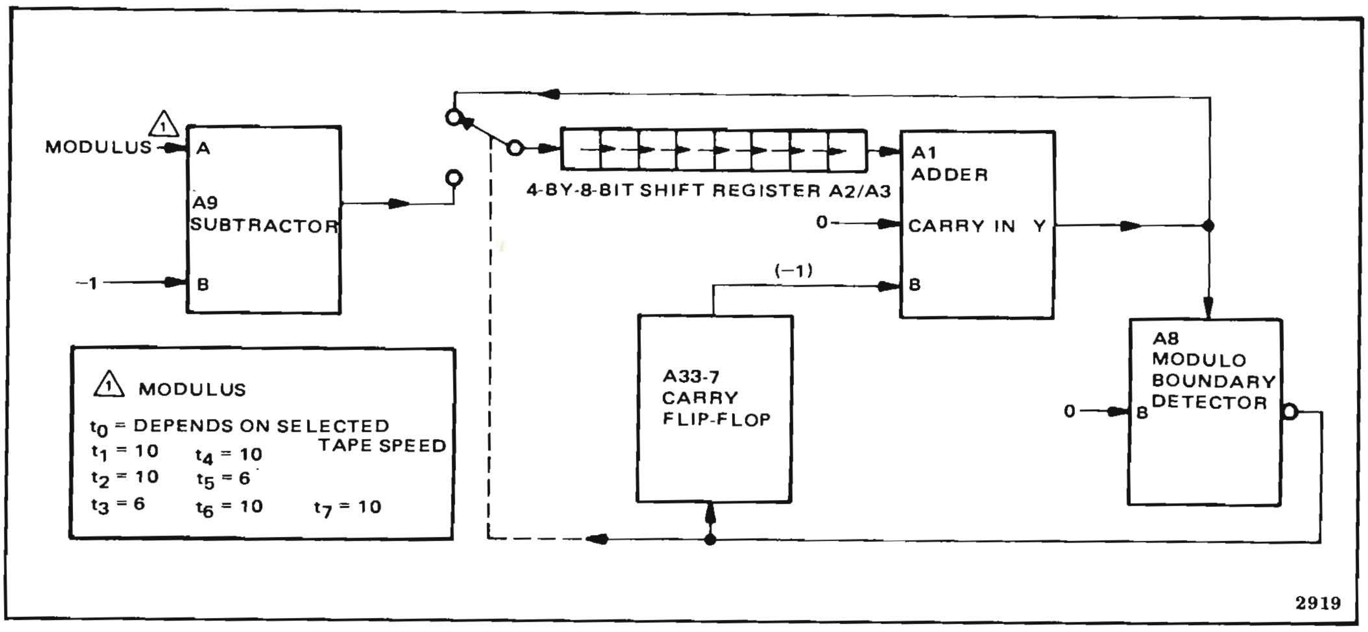



**Figure 4-35. Count Down Logic, Simplified Block Diagram**

The output of adder A1 is also sent to the A input of the modulo boundary detector A8. The B input to modulo boundary detector A8 will always be 0 during the count-down mode. Ones subtractor A9 is used to input the data into shift register A2/A3 when a borrow is detected. The A input to ones subtractor A9 is the modulus for that specific digit. During time $t_0$, the modulus at the A input to ones subtractor A9 will be 8, 4, 2, or 1 for selected tape speeds of 30, 15, 7.5, and 3.75 inches per second, respectively. All four B inputs will always be high during count down thereby adding 15 (or the sixteens complement of one). Therefore, during count down, the sum output of the ones subtractor A9 will always be equal to the modulus minus 1. This ensures that the correct number is present to succeed zero in the count-down sequence.

When a tach pulse has been received during the previous cycle ($t_0$ through $t_7$), carry flip-flop A33-7 is set at start of $t_0$. The set output from carry flip-flop A33-7 is gated to the B inputs of adder A1 via NOR gate A20-13; therefore, when the carry flip-flop is set, all B inputs will be high. When the carry flip-flop A33-7 is reset, all B inputs will be low. At time $t_0$, the least significant digit is shifted out of shift register A2/A3 to adder A1.

If a tach pulse was not received, the sum output of adder A1 will be recirculated to the input of shift register A2/A3 unchanged. If a tach pulse was received in the previous cycle, carry flip-flop A33-7 is set at $t_0$ and the least significant digit that is being shifted out at this time is summed with the B input to adder A1, which is all ones. By adding all ones (or the sixteens complement of one) to the output of the shift register, one is subtracted from the count. The sum from adder A1 is sent to modulus boundary detector A8 where it is transferred to the inputs of NAND gate A31-6 unchanged since, during count down, only 0 (all B inputs low) is added to the sum from adder A1 by A8. If decrementing the least significant digit generates a 15 (0 minus 1 equals 15 in hexadecimal), NAND gate A31-6 goes low and sets carry flip-flop A33-7 at the end of $t_0$.

At the same time that NAND gate A31-6 goes low, the output of ones subtractor A9 is substituted for that of adder A1 at the input of 4-by-8-bit shift register A2/A3. This output is always equal to one less than the modulus of the digit currently being processed. At $t_1$, the second least significant digit is transferred out of shift register A2/A3 to adder A1. If at $t_0$ the carry flip-flop A33-7 was set, the second least significant

bit will be decremented. The output of adder A1 is checked by modulo boundary detector A8 in the same manner as during $t_0$ for a count of 15. If the count of 15 is not detected, the output of the adder is recirculated back to 4-by-8 shift register A2/A3.

If 15 (15 equals zero count) is detected as the result of decrementing the digit from the shift register, the output of ones subtractor A9 is shifted into 4-by-8-bit shift register A2/A3 as the correct number to follow zero in the count-down sequence. In a similar manner, the remaining digits, $t_2$ through $t_7$, are processed in the count-down mode with the exception that during $t_7$ the output of the carry flip-flop A33-7 is disabled.

**4-101. Tape Run Out.** If the tape runs out, tach pulses may still be generated by the tachometer wheel due to inertia. In order to prevent the tach pulses from being counted, an abort signal, generated by the tape transport when the tape runs out, inhibits the output from carry flip-flop A33-7. The abort signal is received by open-collector buffer A37-8. The output of open-collector buffer A37-8 is "wired-ORed" with buffer A37-10, which buffers the output of the carry flip-flop A33-7. When the abort signal goes low, the buffered output of the carry flip-flop A33-7 is held low by buffer A37-8 and further counting of tach pulses is inhibited.

**4-102. Power Supply Functional Description**

The power supply assembly, with the exception of three transport mounted transistors, filter capacitors, rectifiers, and transformer, is contained on a single PWA. Main ac power is connected to the ATR-100 through a captive 3-wire power cable attached to the power supply bracket. Power is applied to the primary windings of the transformer via the POWER ON/OFF switch which is mechanically linked to the transport assembly. A jumper plug arrangement in the primary of the power transformer allows selection of any one of four input voltage ranges of 50 or 60 Hertz primary power to be used with the ATR-100. The primary power input voltages that can be accommodated by this arrangement are: 90 to 115 Vac, 110 to 135 Vac, 180 to 230 Vac, and 220 to 270 Vac. The power supply assembly provides unregulated ±20 Vdc (nominal) for use by the reel and capstan servo motors, electronically filtered ±20 Vdc (nominal) for use by the audio circuits, and regulated +5 Vdc for use by the TTL circuits. Additionally, the power supply assembly also contains the current sense resistors for the reel motors and the dynamic braking circuits to stop the reel motors in the event of loss of power or control.

**4-103. Power Supply Circuit Details**

The power supply assembly is a separate self-contained assembly with the exception of three series-pass transistors located on the transport assembly. Figure 4-36 is a simplified block diagram of the power supply assembly and drawing number 4840458 is the schematic diagram.

**4-104. AC Supply.** As shown in Figure 4-36, the main ac power to the power supply assembly is supplied to transformer T1 via fuse F1 and switch S1. Taps from transformer T1 to the switched main ac power are accessible via a jumper plug arrangement on the power supply assembly to allow the use of one of four input voltage ranges to be selected as the input to transformer T1 and to provide 115 Vac to the transport. The secondary of transformer T1 consists of three windings. One winding provides ac input to the 5-Vdc regulated supply. The other two windings provide the ac input to the 20-volt electronically filtered supply and 20-volt servo supply.

**4-105. 20-Volt Servo Supply.** The 20-volt servo supply consists of a rectifier and isolation network which provide the +20 Vdc and −20 Vdc to the reel-motor and capstan servos. Unregulated 20-Vdc rectifier A2 consists of a bridge rectifier assembly and two filter capacitors. The bridge rectifier assembly is connected to the secondary windings of transformer T1 to act as two full-wave rectifiers, one for the +20 Vdc and the other for the −20 Vdc. A filter capacitor at the output of each full-wave rectifier filters the +20 Vdc and −20 Vdc. The filtered +20 Vdc and −20 Vdc is supplied to the capstan motor via an isolation network consisting of diodes CR3/CR4 and filter capacitors C6/C7.

**4-106. 20-Volt Electronically Filtered Supply.** The 20-volt electronically filtered supply consists of 20-volt rectifier A1, +20-Vdc floating reference

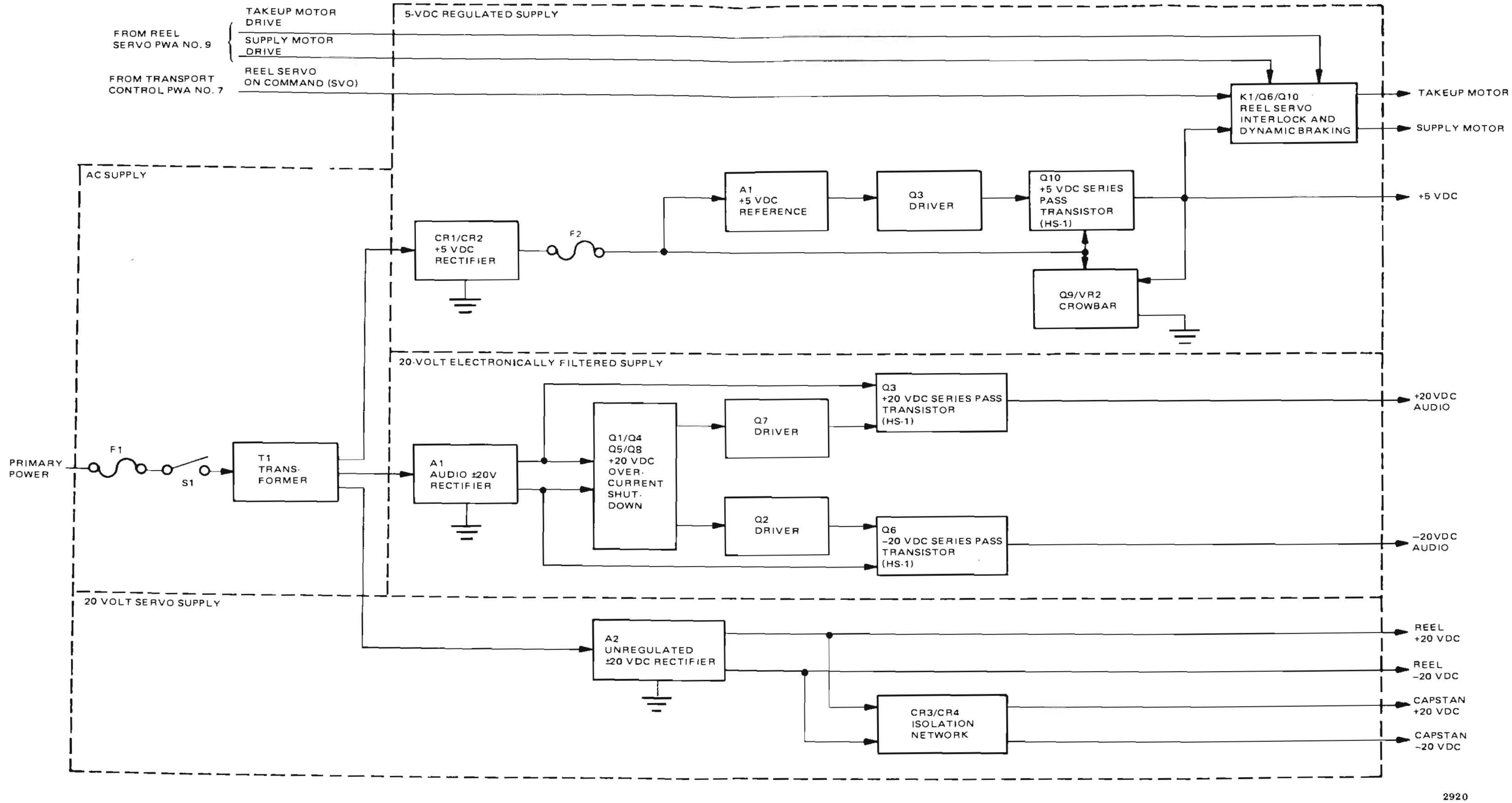



Figure 4-36. Power Supply Assembly, Simplified Block Diagram

capacitor C7, -20-Vdc floating reference capacitor C3, overcurrent shutdown transistors Q5/Q8/Q4/Q1, +20-Vdc driver Q7, -20-Vdc driver Q2, +20-Vdc series-pass transistor Q8, and -20 Vdc series-pass transistor Q9. (Q8 and Q9 are located on the transport heat sink.) The 20-volt electronically filtered supply provides +20 Vdc and -20 Vdc (22 Vdc, nominal) for use by the audio circuits. The 20-volt rectifier A1 is a bridge rectifier assembly connected to the secondary winding of transformer T1 to act as two full-wave rectifiers; one rectifier to provide the +20 Vdc and the other rectifier to provide the -20 Vdc. The outputs of 20-volt rectifier A1 provide the +20-Vdc and -20-Vdc floating references via capacitor C7 and driver Q7 for the +20-Vdc and via capacitor C3 and driver Q2 for the -20 Vdc. Drivers Q7 and Q2 provide the electronically filtered +20 Vdc and -20 Vdc to the +20-Vdc series-pass transistor Q8 and -20-Vdc series-pass transistor Q9, respectively. Overcurrent shutdown transistors Q5/Q8/Q4/Q1 provide dual shutdown of the +20-Vdc and -20-Vdc outputs when excessive current is drawn from either output. If excessive current is drawn from either +20-Vdc or -20-Vdc output, overcurrent shutdown transistors Q5/Q8/Q4/Q1 will cause both outputs to go to 0 Vdc and remain at 0 Vdc until power is removed for approximately 10 seconds and reapplied. Transistors Q5 and Q4 and resistors R6 and R16 provide current sensing for the +20-Vdc and -20-Vdc outputs, respectively. The output at the collectors of Q5 and Q4 go to the bases of each other and to the bases of transistors Q8 and Q1, which shunt the floating references to drivers Q7 and Q2 and cause the outputs to go to 0 Vdc for both +20 Vdc and -20 Vdc.

**4-107. 5-Vdc Regulated Supply.** The 5-Vdc regulated supply consists of +5-Vdc rectifier CR1/CR2, +5-Vdc reference A1, +5-Vdc driver Q3, +5-Vdc series-pass transistor Q10, and crowbar Q9. The current for A1 is supplied from the audio +20V source. It is routed through R5, CR5, and filtered by C1. Additionally, reel servo interlock and dynamic brake K1/Q6/Q10 are operated from the 5-Vdc regulated supply. The 5-Vdc regulated supply provides the +5 Vdc to the TTL circuits on the ATR-100. The reel servo interlock and dynamic braking provides dynamic braking of the takeup and supply motors in the event of power failure or loss of reel servo control.

The +5-Vdc rectifier CR1/CR2 consists of a full-wave rectifier and associated filter capacitor. The rectified +5 Vdc goes to +5-Vdc reference A1 and +5-Vdc series-pass transistor Q10, via a 5 ampere fuse (F2). The +5-Vdc reference A1 provides a reference voltage to the base of driver Q3, which is connected to +5-Vdc series-pass transistor Q10 in a darlington configuration. Series-pass transistor Q10 provides the current required by the TTL circuits at the reference voltage minus the voltage drop across the base-to-emitter drop of Q3 and Q10. Part of output from +5-Vdc series-pass transistor Q10 is sampled by crowbar Q9 via 5.6V zener diode VR2. When the voltage at the output of series-pass transistor Q10 rises above +5.6V plus the trip voltage required to trigger SCR Q9, the current through zener diode VR2 rises and provides the gate current to SCR Q9 in crowbar Q9/VR2. SCR Q9 is connected across the +5-Vdc input, to series-pass transistor Q10, and ground. When SCR Q9 conducts, the +5-Vdc input to series-pass transistor Q10 is shunted to ground causing fuse F2 to open.

Reel servo interlock and dynamic brake K1/Q6/Q10 contains relay driver Q6/Q10, double-pole double-throw relay K1, full-wave rectifier CR9/CR10, and motor loads DS1/R15 and DS2/R4. Reel servo interlock and dynamic brake K1/Q6/Q10 disconnects the output of supply motor MDA and takeup motor MDA from the supply and takeup motors, respectively, and connects the motor loads to the motor to provide dynamic braking when reel servo on (SVO) goes high or +5 Vdc is lost.

Full-wave rectifier CR9/CR10 provides +24 Vdc from transformer T1 to the high (A) side of relay coil K1. The return for relay coil K1 is provided by relay driver Q6/Q10. When SVO is low (0 Vdc) and +5 Vdc is present at the output of the 5-Vdc regulated supply, relay driver Q6/Q10 provides a return path and energizes relay coil K1. When K1 is energized, the supply motor MDA is connected to the supply motor and the takeup motor MDA is connected to the takeup motor. If SVO goes high or +5 Vdc is lost, K1 is de-energized. When K1 is de-energized, the takeup motor is switched from the takeup motor MDA to motor load DS1/R15 and the supply motor is switched from the supply motor MDA to motor load DS2/R4. Motor loads

DS1/R15 and DS2/R4 provide a path for the current generated by the back emf of the motor when the motor MDA is disconnected, thereby causing a braking action to stop the motor. Diodes CR1 and CR2 are steering diodes that allow only the following or trailing motor to be used as a brake while the forward, or leading motor, is allowed to run free. Voltage suppressors inhibit the back EMF when the relay contacts open.

# SECTION 5

# MAINTENANCE

## 5-1. GENERAL

This section of the manual provides maintenance information for the ATR-100 Series Recorder/Reproducer and input/output assembly (accessory). Maintenance information is grouped under six main headings: *Overall Test Equipment Requirements, Preventive Maintenance, Conversion, Alignment* and *Adjustments, Performance Tests,* and *Corrective Maintenance.*

Under the heading *Overall Test Equipment Requirements,* Table 5-1 lists test equipment (electronic and mechanical) for testing, adjusting, and maintenance of the ATR-100. *Preventive Maintenance* covers procedures for cleaning, demagnetizing, and lubrication. *Conversion* includes procedures for changing channel configuration, tape width, operating speed pair, master bias operation, and input/output assembly operating configuration. Information grouped under the heading *Alignment* and *Adjustments* includes procedures for the audio signal system and the tape transport. Information under the heading *Performance Tests* includes tests for checking tape tension, absolute tape-speed accuracy, speed variation, operating level, signal-to-noise ratio, harmonic distortion, intermodulation distortion, and flutter. *Corrective Maintenance* covers procedures for head maintenance, troubleshooting, and component replacement procedures.

**CAUTION**

**DO NOT USE ANY FORM OF ABRASIVE LAPPING TAPE ON THE ATR-100 FERRITE HEADS AS SERIOUS DAMAGE CAN OCCUR AND HEAD WARRANTY WILL BE VOIDED.**

**TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS, ALWAYS TURN RECORDER/REPRODUCER POWER OFF BEFORE REMOVING OR INSTALLING A HEAD ASSEMBLY, OR BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) IN THE RECORDER/REPRODUCER OR INPUT/OUTPUT ASSEMBLY.**

## 5-2. OVERALL TEST EQUIPMENT REQUIREMENTS

Electronic and mechanical test equipment suggested for use during testing, alignment, adjustment, and maintenance of the recorder/reproducer is listed in Table 5-1. Test equipment with equivalent or better specifications can be substituted for the equipment suggested in the table.

**Table 5-1. Overall Test and Maintenance Equipment Requirements**

| EQUIPMENT TYPE | SUGGESTED MODEL | USED FOR |
|---|---|---|
| AC Voltmeter | Hewlett-Packard Model 400 FL | Performance check and electronic alignment |
| DC Voltmeter — 20,000 ohms/volt | Any | Electronic checks and adjustments |
| Audio Oscillator | Hewlett-Packard Model 204C or 209D | Performance check and electronic alignment |
| Wave Analyzer or Spectrum Analyzer | Wave Analyzer Hewlett-Packard Model 3581A or Spectrum Analyzer Hewlett-Packard Model 3580A | Erasure and distortion measurements |

Table 5-1. Overall Test and Maintenance Equipment Requirements (Continued)

| EQUIPMENT TYPE | SUGGESTED MODEL | USED FOR |
|---|---|---|
| Intermodulation Analyzer | Crown Model IMA | SMPTE intermodulation distortion measurement |
| Oscilloscope (dual trace) | Tektronix Model 465 | Head azimuth adjustment and signal system, tachometer, and servo alignment |
| Band Limiting Filter – 30 Hz to 18 kHz | See Figure 5-34 | Signal-to-noise measurement |
| ANSI 'A' Weighted Filter | See Figure 5-35 | Signal-to-noise measurement |
| Universal Noise Filter (optional) | See Figure 5-36 | Signal-to-noise measurement |
| Flux Loop | Ampex P/N 4020423-01 | Performance check and electronic alignment |
| Flux Loop Equalizing Amplifier | Ampex P/N 4020424-01 | Performance check and electronic alignment |
| Tape Tension Gauge | AMPEX 360-476 | Measuring tape tension |
| Head Demagnetizer | Ampex P/N 4040575 | Demagnetizing head stacks |
| Hand Held Bulk Demagnetizer | Any | Demagnetizing tape guides and other components in the tape path |
| Head Cleaner | Ampex P/N 4010823 or 087-007 | Cleaning heads |
| Lubricants | See text (paragraph 5-9) | Lubrication of components |
| Isopropyl Alcohol (approximately 92%) | Any | Cleaning tape guiding components |
| Technicians Tools | | |
| I/O Level Set Accessory (optional – see text paragraph 5-52) | Ampex P/N 4020425 | Alignment of input/output assembly (accessory) |
| Automatic Record/Play Cycler (optional) | See text (paragraph 5-62) | PURC timing alignment |
| Flutter Meter | Micom Model 8100W with Analyzer | Flutter measurement and trouble-shooting |
| Frequency Counter | Hewlett-Packard Model 5300A/5302A | Tape speed and speed variation check |
| Extender Board | Ampex P/N 4050800-01 (supplied with recorder/reproducer) | Extends electronics assembly PWAs for test |
| Extender Board | Ampex P/N 4020430-01 | Extends input/output module for test |

ALIGNMENT/TEST TAPES

| SPEED | EQUALIZATION | STANDARD | TRACKS | PART NUMBER |
|---|---|---|---|---|
| 1/4" ALIGNMENT TAPE | | | | |
| 3.75 in/s | 90 $\mu s$ and 3180 $\mu s$ | NAB/IEC | Full | 4690037-01 |

Table 5-1. Overall Test and Maintenance Equipment Requirements (Continued)

| ALIGNMENT/TEST TAPES (Continued) | | | | |
|---|---|---|---|---|
| SPEED | EQUALIZATION | STANDARD | TRACKS | PART NUMBER |
| 1/4" ALIGNMENT TAPE (Continued) | | | | |
| 7.5 in/s | 50 $\mu$s and 3180 $\mu$s | NAB | Full | 01-31321-01 |
| 7.5 in/s | 50 $\mu$s and 3180 $\mu$s | NAB | 2 | 4690010-01 |
| 7.5 in/s | 70 $\mu$s and $\infty$ | IEC** | Full | 4690014-01 |
| 15 in/s | 50 $\mu$s and 3180 $\mu$s | NAB | Full | 01-31311-01 |
| 15 in/s | 50 $\mu$s and 3180 $\mu$s | NAB | 2 | 4690009-01 |
| 15 in/s | 35 $\mu$s and $\infty$ | IEC** | Full | 01-31313-01 |
| 30 in/s | 17.5 $\mu$s and $\infty$ | AES | Full | 4690093-01 |
| 1/2" ALIGNMENT TAPE*** | | | | |
| 7.5 in/s | 50 $\mu$s and 3180 $\mu$s | NAB | Full | 01-31321-05 |
| 7.5 in/s | 70 $\mu$s and $\infty$ | IEC** | Full | 4690015-01 |
| 15 in/s | 50 $\mu$s and 3180 $\mu$s | NAB | Full | 01-31311-05 |
| 15 in/s | 35 $\mu$s and $\infty$ | IEC** | Full | 01-31313-05 |
| 30 in/s | 17.5 $\mu$s and $\infty$ | AES | Full | 4690085-01 |
| SPEED | FREQUENCY | LEVEL | TRACKS | PART NUMBER |
| 1/4" LEVEL TAPES | | | | |
| 7.5 in/s | 700 Hz | Operating* | Full | 01-31325-01 |
| 15 in/s | 700 Hz | Operating* | Full | 01-31315-01 |

*OPERATING LEVEL, at 500 and 700 Hz, corresponds to a tape flux per unit width of 185 nWb/m. (Refer to: McKnight, John G., "Flux and Flux-Frequency Measurements and Standardization in Magnetic Recording," Journal of the SMPTE, Vol. 78, June 1969, pp 457-472.)

**Also CCIR.

***All listed 1/2-inch alignment tapes have flux/frequency characteristics which include compensation for fringing.

## 5-3. PREVENTIVE MAINTENANCE

It is important that preventive maintenance, consisting of cleaning, demagnetizing, and lubrication procedures, be performed at the intervals recommended.

### 5-4. Cleaning

The following paragraphs discuss frequency of and methods to be used when cleaning the tape path and optical devices of the recorder/reproducer.

**5-5. Tape Path Cleaning.** Oxide particles from the magnetic tape tend to collect on components in the tape path. These oxide accumulations degrade the performance of the recorder/reproducer. The heads and all other components in the tape path should be cleaned after each eight hours of operation, or more frequently if visual inspection indicates cleaning is needed. Frequency of cleaning required depends greatly on the quality of tape in use.

**CAUTION**

**WHEN CLEANING THE HEADS, USE HEAD CLEANER ONLY AND DO NOT USE METAL OR ANY TOOLS THAT COULD SCRATCH HEADS. DO NOT USE HEAD CLEANER ON THE TAKEUP TENSION ARM ROLLER.**

Proceed as follows:

1. Clean each head thoroughly with cotton-tipped applicator dampened with Ampex

Head Cleaner (part number 4010823 or 087-007).

2. Clean all tape-guiding components, supply tension arm, tape timer wheel, capstan, and tension arm rollers with 92% (approximately) isopropyl alcohol. Do not allow alcohol to enter bearings.

3. Clean scrape-flutter idler (on head assembly) with a dry cotton-tipped applicator.

**5-6. Optical Devices.** Optical devices on the ATR-100 seldom need cleaning and *should not be cleaned on a routine basis*. However, if required, clean the capstan tach disc and photo sense devices as follows:

1. Clean capstan tach disc with a soft lint-free cloth or Kimwipe moistened with Windex or isopropyl alcohol. Instructions for removal of the capstan/tach assembly are given in paragraph 5-97.

**CAUTION**

**DO NOT USE ANY SOLVENTS, ALCOHOL, WINDEX, OR CLEANER OTHER THAN WATER, ON ANY PHOTOPOTENTIOMETER, LED, OR ANY PHOTO SENSE DEVICE. TO DO SO WILL CAUSE DAMAGE TO THE PLASTIC COVER.**

2. Clean the LED's photopotentiometers, or any photo sense device with dry cotton-tipped applicator or, if necessary, an applicator moistened only with water.

## 5-7. Demagnetizing

The head should be demagnetized after each eight hours of operation.

**CAUTION**

**DO NOT REMOVE THE HEAD ASSEMBLY OR A PRINTED WIRING ASSEMBLY (PWA) WITH POWER ON. TO DO SO WILL CAUSE THE HEAD TO BECOME MAGNETIZED.**

Heads and other components in the tape path can acquire permanent magnetization that degrades signal-to-noise, increases distortion, and partially erases high frequencies on recorded tapes. Use an Ampex Head Demagnetizer (part number 4040575) or equivalent to demagnetize components in the tape path.

**CAUTION**

**REMOVE RECORDED TAPE FROM THE VICINITY OF THE DEMAGNETIZER TO PREVENT ACCIDENTAL TAPE ERASURE.**

Proceed as follows:

1. Turn equipment power off and remove any recorded tape that is near the transport.

2. Remove transport head cover assembly.

3. Cover the head demagnetizer tips with an adhesive tape.

4. With demagnetizer at least three feet away from head assembly, connect demagnetizer to an appropriate ac power source.

5. Slowly move demagnetizer toward one head stack and lightly place demagnetizer tip to the base of the stack straddling head gap.

6. Using a slow, even motion, move the demagnetizer tips up and down the entire face of the stack several times. Then, slowly withdraw the demagnetizer.

7. Repeat steps 5 and 6 for each head stack.

8. Slowly move the demagnetizer at least three feet from the head assembly and then unplug the demagnetizer.

## 5-8. Scrape Flutter Idler

The only item on the recorder/reproducer that requires periodic lubrication is the scrape flutter idler. Ultrasonically clean and then lubricate the scrape flutter idler once a year or after each 2,000 hours of operation. The idler should be removed from the head assembly and delivered to a local jeweler or watchmaker who has an ultrasonic cleaner and special jewel oil.

Proceed as follows:

1. Remove head assembly from the transport (refer to *Changing Head Assembly* text, paragraph 5-87).

2. Remove head shield (four Allen-head screws shown in Figure 1-3).

3. Loosen scrape flutter idler retaining screw shown in Figure 5-1 and remove idler from head assembly base.

NOTE

**Step 4 should be performed by a jeweler or watchmaker.**

4. Loosen the two Allen-head bearing clamp screws (Figure 5-2) in the yoke assembly. Slide the two jewel bearing holder assemblies out of the yoke and remove the idler.

   a. Ultrasonically clean the two jewel bearing holder assemblies and the idler.

   b. Lubricate each jewel bearing holder assembly with one drop of jewel oil (or Ampex precision instrument oil, part number 087-239). Use a No. 21 gauge hypodermic needle to apply oil to bearing.

   c. Reassemble idler and jewel bearing holder assemblies into the yoke and lightly tighten the two bearing clamp screws.

5. With the upper and lower bearing clamp screws loose, set idler height (Figure 5-2) to 0.035 $\pm$0.005 inch above the yoke base. Lightly tighten lower bearing clamp screw.

6. With upper bearing clamp screw still loose, remount idler onto the head base plate with front and side of yoke even with the two scribed lines on the base plate (Figure 5-1).

7. While pressing upper jewel bearing holder assembly toward idler with very light finger pressure, lightly tighten upper bearing clamp screw. Spin idler with finger. Idler should spin freely with no evidence of binding.

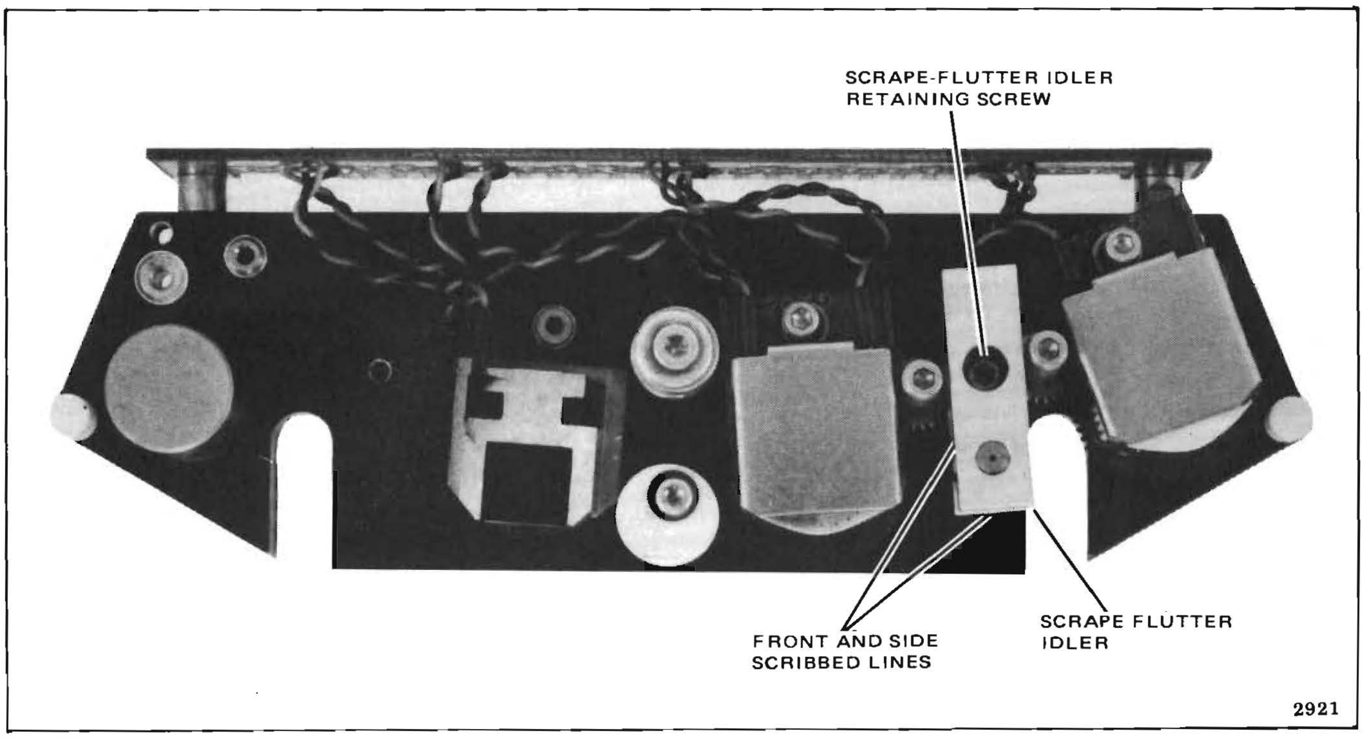



Figure 5-1. Top View of Head Assembly, Head Shield Removed

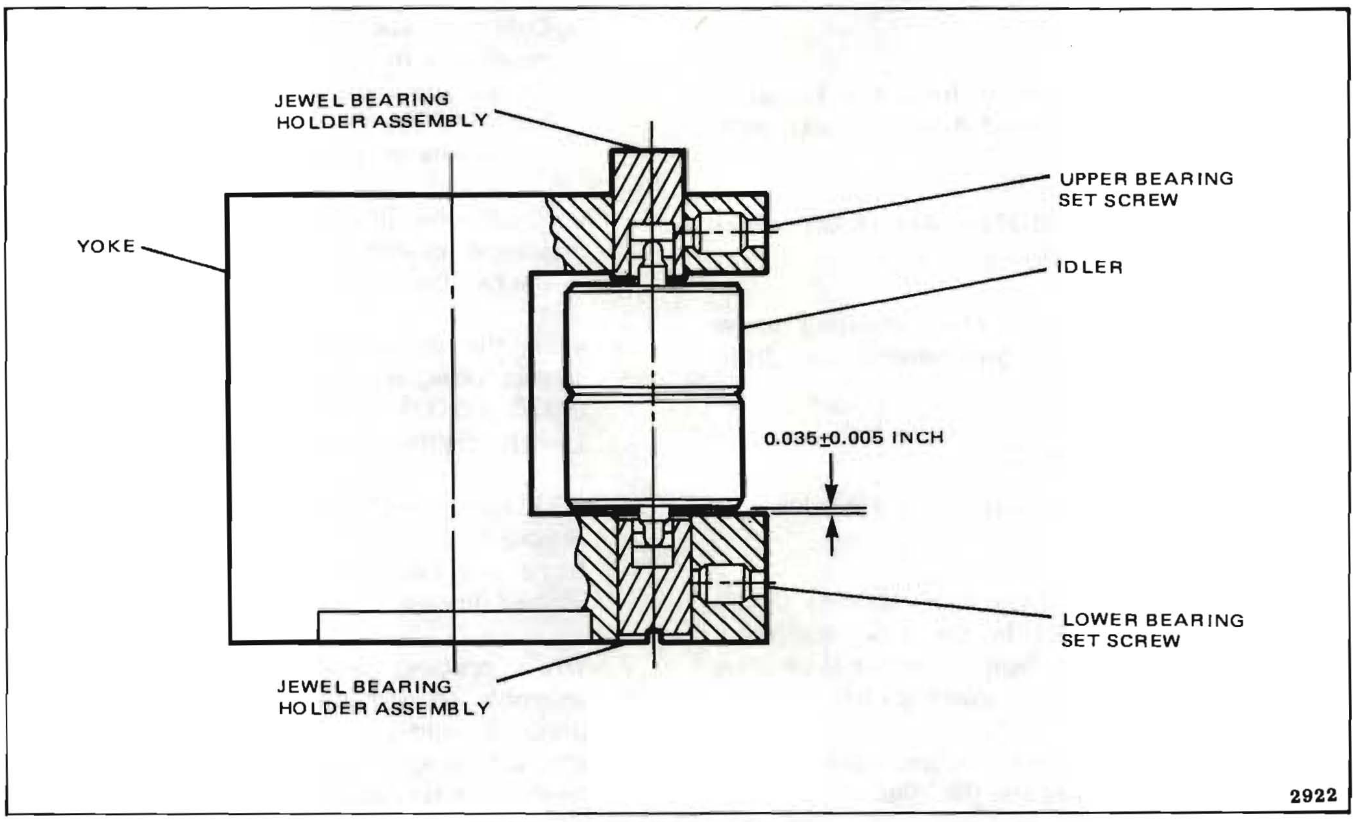



**Figure 5-2. Scrape Flutter Idler, Side Cross-Section View**

8. Reinstall head shield (four Allen-head screws) and install head assembly onto transport.

## 5-9. Lubrication

Table 5-2 provides a list of lubricants used on the recorder/reproducer, where the lubricants are used, and application instructions. Note that the capstan motor and tape timer bearings do not require relubrication. If these bearings are replaced with non-prelubricated bearings, use the grease suggested in the table. Except for the scrape flutter idler, which should be cleaned and lubricated after each 2,000 hours of operation, the other items shown in the table should be lubricated as required for proper operation.

**5-10. Head Gate Support Bushing.** There is only one support for the head gate assembly. The support consists of a shaft (Figure 5-30) that slides inside a bushing that is threaded into the tape transport casting. This bushing has been permanently lubricated; however, if additional lubrication is required, proceed as follows:

1. With the head gate in the latched (down) position, lightly apply $MoS_2$ high pressure grease (Table 5-2) to the entire surface of the shaft (Figure 5-31).

2. Operate the head gate up and down to distribute the grease inside the bushing bore. Remove any excess grease from shaft or bushing.

**5-11. Tape Lifter Arm Bushings.** The two tape lifter arm bushings have been permanently lubricated; however, if additional lubrication is required, proceed as follows:

1. Remove the head assembly (paragraph 5-87).

2. Loosen the 6-32 cap screw in the tape-lifter roller (Figure 5-28) nearest the tape lifter

Table 5-2. Lubricants Used on Recorder/Reproducer

| WHERE USED | LUBRICANT DESCRIPTION | APPLICATION INSTRUCTIONS |
|---|---|---|
| Tape lifter and head gate support bushings | Grease, $MoS_2$, high pressure, mfd. by Dow Corning Corp., Midland, Michigan | Rub grease into entire surface of bushing bore. |
| Tape lifter solenoid | Grease, O-ring, mfd. by Parker Seal Co., Culver City, California | Use a small amount around solenoid O-ring. |
| Scrape flutter idler | Instrument oil<br>Ampex Part No. 087-239 | Ultrasonic clean parts. Use one drop from a No. 21 Stubbs gauge on each bearing. |
| Capstan bearings and shaft and tape timer bearing | Grease, general purpose channeling, ANDOK-C. Source: Barden Corp., Danbury, Connecticut | Fill each bearing 30 to 40% if bearings are not prelubricated upon replacement. |

solenoid and remove the tape lifter shaft from the roller and the bushing.

3. Loosen the 6-32 cap screw in the tape-lifter roller (Figure 5-28) furthest away from the tape-lifter solenoid and remove the tape lifter shaft from the roller and the bushing.
4. Rub $MoS_2$ high pressure grease (Table 5-2) into the entire surface of the bushing bore. Remove any excess from bushing.
5. Reinstall the two tape lifter shafts in the reverse order of removal, but do not firmly tighten screws.
6. Reinstall head assembly (paragraph 5-87).
7. Perform steps 4 through 15 of the *Tape Lifter Arms* adjustment procedure, paragraph 5-69.

## 5-12. CONVERSION

Procedures for changing channel configuration, tape width, and operating-speed pair are presented in the text that follows. (For Ampex part numbers of components required for conversion, refer to Tables 1-2 and 1-3.)

### 5-13. Changing Channel Configuration

The ATR-100 Series Recorder/Reproducer is prewired to operate with up to four audio channels. The four-channel control unit is used to operate a one-, two-, or four-channel system. To change channel configuration, proceed as follows:

1. For each audio channel, install a Main Audio PWA and associated PADNET PWA into the electronics assembly as follows:
   a. For a full-track, 1/4-inch tape system, install a Main Audio PWA and PADNET PWA into position 1 in the electronics assembly.
   b. For a two-channel, 1/4-inch tape system, install a Main Audio PWA and PADNET PWA into positions 1 and 2 in the electronics assembly.
   c. For a four-channel, 1/2-inch tape system, install a Main Audio PWA and PADNET PWA into positions 1, 2, 3, and 4 in the electronics assembly.
2. Install the appropriate head assembly (refer to *Changing Head Assembly* text, paragraph 5-87).
3. If conversion involves changing tape width, refer to *Changing Tape Width* procedure, paragraph 5-14.
4. Perform the appropriate signal system alignment procedures given under *Alignment and Adjustments*, paragraph 5-29.

## 5-14. Changing Tape Width

Converting the tape transport to accommodate 1/4-inch tape or 1/2-inch tape is accomplished by changing the tape guides on the supply and takeup constant-tension arms and changing the head assembly. After conversion, no electrical tension adjustments are required as a jumper on the head connector causes the tape tensions to be automatically changed. Proceed as follows:

1. Remove tape guide by unscrewing the captive knurled-head screw (Figure 5-3) that secures tape guide to the constant tension arm.
2. Clean top surface of tension arm and bottom surface of tape guide with 92% isopropyl alcohol.
3. Install tape guide on tension arm. Secure (finger tight) to arm with captive knurled-head screw supplied with tape guide. (Do not use a screwdriver to tighten screw.)
4. Install the appropriate head assembly (refer to *Changing Head Assembly* text, paragraph 5-87).

## 5-15. Changing Operating-Speed Pair and Master Bias Operation

The recorder/reproducer can operate at any tape-speed pair selected from the following speeds: 3.75, 7.5, 15, and 30 in/s. (Machines originally shipped from the factory are set to operate at 7.5 and 15 in/s with four-speed master bias operation.) Note that if a speed is selected on the transport control panel (Table 3-1) for which the signal system or master bias has not been set up, the LOCKOUT indicator will light, and play and record modes for that speed will be inhibited. In addition, the audio output(s) of the basic recorder/reproducer will be muted. If an input/output assembly is being used, the assembly will switch to input signal monitoring.

### NOTE

**On ATR-100's utilizing a 4-speed PADNET, repositioning of PADNET jumpers is not required. However, tape speed switches S2 and S3 must be set to the desired speed.**

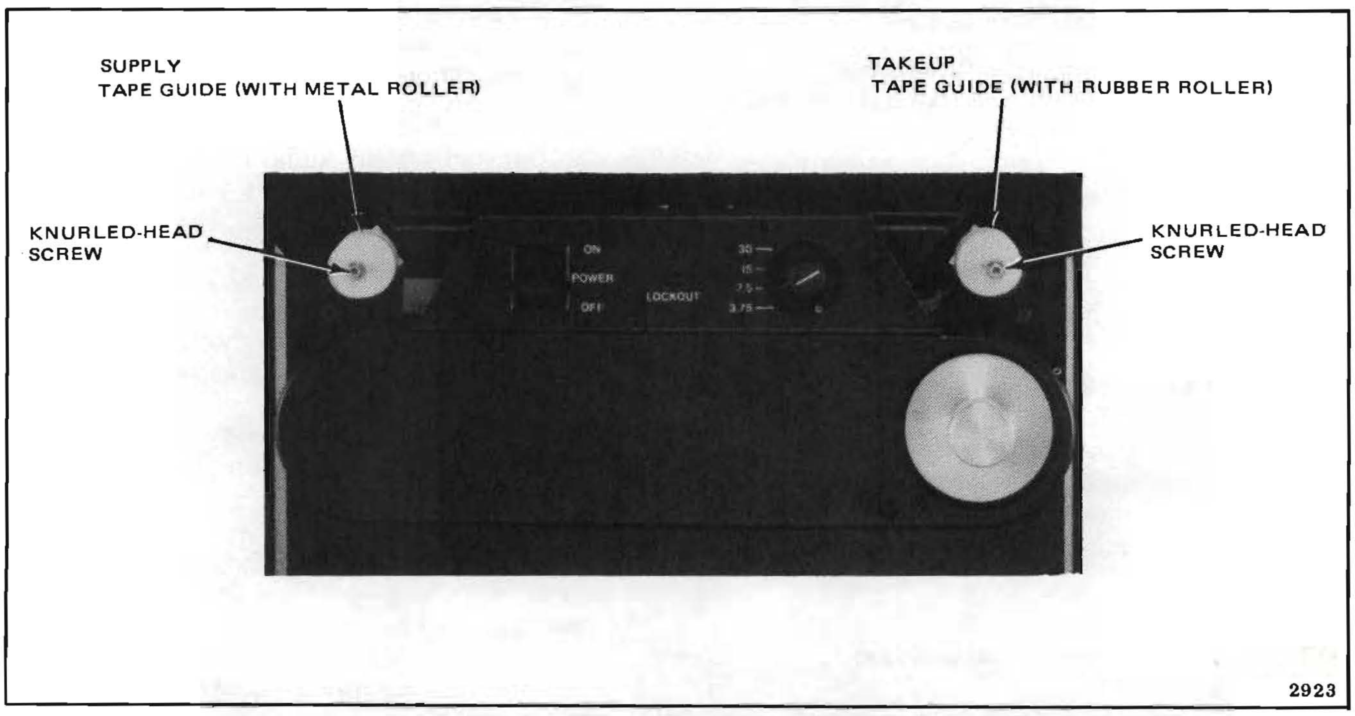



**Figure 5-3. Tape Guide Securing Screws**

To change operating-speed pair and master bias operation, jumper plugs are repositioned on Audio Control PWA No. 5 and on the PADNET PWA(s). The jumper plugs on the Audio Control PWA No. 5 permit the user to program the recorder/reproducer for two-speed (dual master bias) operation or four-speed master bias operation. When the recorder/reproducer is programmed for two-speed master bias operation, a bias switch on the front panel of Audio Control PWA No. 5 (Figure 5-4) enables the operator to select one of two different master bias levels for each of the two operating speeds.

When the recorder/reproducer is programmed for four-speed operation, the bias switch is permanently placed in the left-hand position and a single master bias level is provided for each speed. This master bias level is automatically switched when a speed is selected on the transport control panel.

NOTE

**If the Audio Control PWA No. 5 jumpers are set for four-speed master bias operation, it is only necessary to reset jumpers on each PADNET when changing operating-speed pair. If the Audio Control PWA No. 5 jumpers are set for two-speed (dual master bias) master bias operation, then the two speeds selected on the Audio Control PWA No. 5 must match those selected on the PADNET PWA(s) or the lockout circuitry will operate.**

1. To change the operating speed pair with a two-speed PADNET installed, proceed as follows:

   a. With power off, and for each channel, remove the PADNET PWA from the electronics assembly.

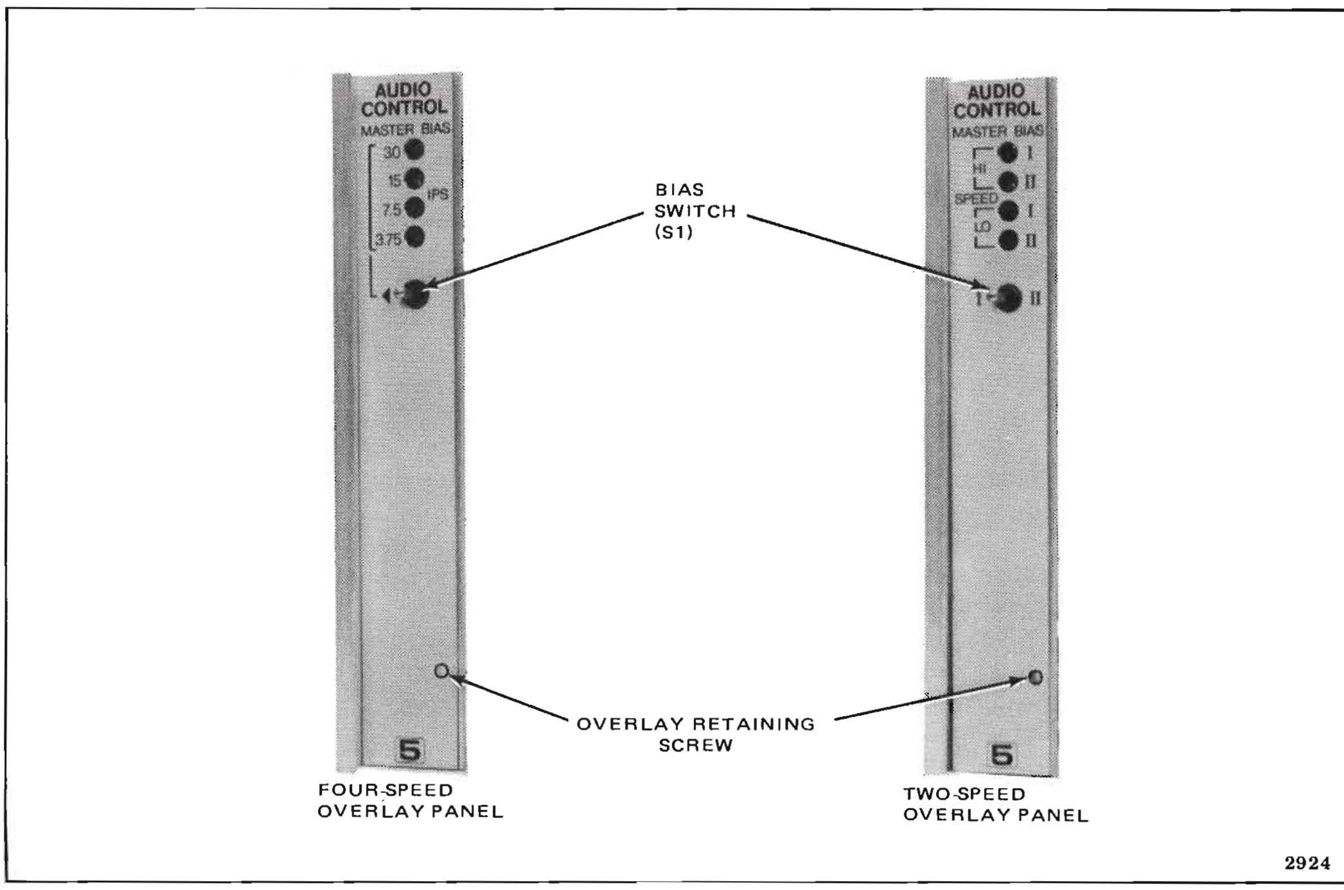



Figure 5-4. Overlay Panel, Audio Control PWA No. 5

b. Position HI speed jumper J1 to the desired high speed: 30, 15, or 7.5 in/s position (Figure 5-5).

c. Position LO speed jumper J2 to the desired low speed: 15, 7.5, or 3.75 in/s position. Reinstall PADNET PWA.

d. For each new speed selected, perform the appropriate signal systen alignment procedure given under *Alignment and Adjustments,* paragraph 5-29.

2. To change the operation speed pair with a four-speed PADNET installed, proceed as follows:

a. With power off, and for each channel, remove the PADNET PWA from the electronics assembly.

b. Position the HI speed switch (S2) to the higher speed of the two speeds selected (see Figure 5-5).

c. Position the LOW speed switch (S3) to the lower speed of the two speeds selected. Reinstall PADNET PWA.

d. Insure proper overlay panel is installed on main audio board (see Figure 5-13).

For each new speed selected, perform the appropriate signal system alignment procedure given under *Alignment and Adjustments,* paragraph 5-29.

**5-16. 2-Speed Dual Master Bias.** For two-speed dual master bias operation, proceed as follows:

1. With power off, remove Audio Control PWA No. 5 from the electronics assembly.
2. Two overlay panels are furnished with the PWA. If the two-speed overlay panel (Figure 5-4) is not in the front position on the PWA, remove front-panel screw, interchange overlay panels, and reinstall screw.
3. Position HI speed jumper J1 to the desired high speed: 30, 15, or 7.5 in/s position (Figure 5-6).
4. Position LO speed jumper J2 to the desired low speed: 15, 7.5, or 3.75 in/s position.
5. Position jumpers J3 and J4 to the S (stored) position. Reinstall Audio Control PWA No. 5.
6. For each new speed selected, perform the appropriate signal system alignment procedure given under *Alignment and Adjustments,* paragraph 5-29.

**5-17. 4-Speed Master Bias.** For 4-speed master bias operation, proceed as follows:

1. With power off, remove Audio Control PWA No. 5 from the electronics assembly.
2. Two overlay panels are furnished with the PWA. If the four-speed overlay panel (Figure 5-4) is not in the front position on the PWA, remove front-panel screw, interchange overlay panels, and reinstall screw.
3. Position jumper J1 to the 30-in/s position (Figure 5-6).
4. Position jumper J2 to the 7.5-in/s position.
5. Position jumper J3 to the 15-in/s position.
6. Position jumper J4 to the 3.75-in/s position. Reinstall Audio Control PWA No. 5.
7. For each new speed selected, perform the appropriate signal system alignment procedure given under *Alignment and Adjustments,* paragraph 5-29.

### 5-18. Changing Input/Output Assembly Operating Configuration

The input/output assembly is shipped from the factory with the following input and output operating characteristics:

- Input impedance — 50K ohms balanced
- Output impedance — 30 ohms balanced

The input/output assembly operating characteristics can be changed by adding a capacitor and by

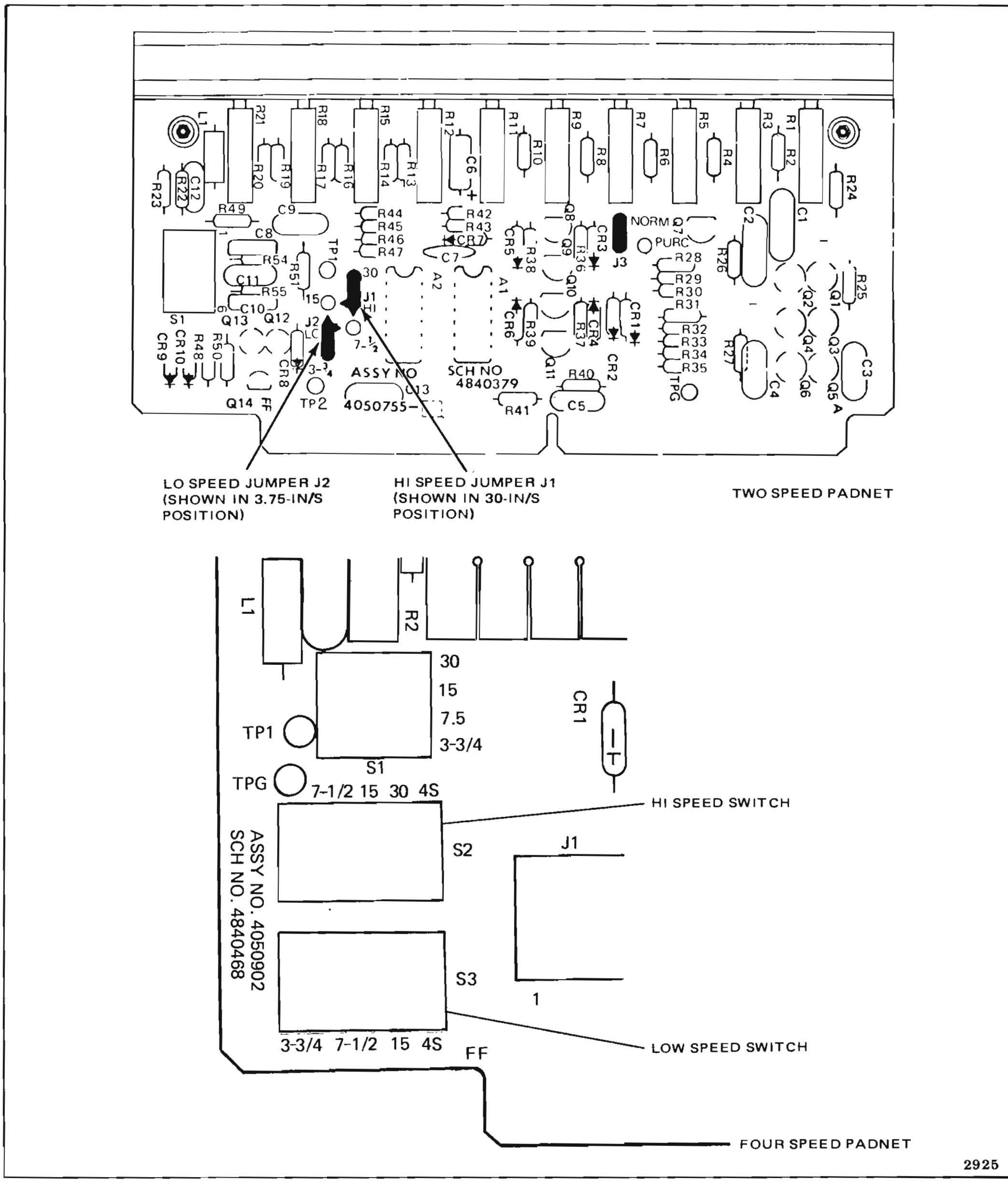



**Figure 5-5. Speed Selection Controls PADNET PWA**

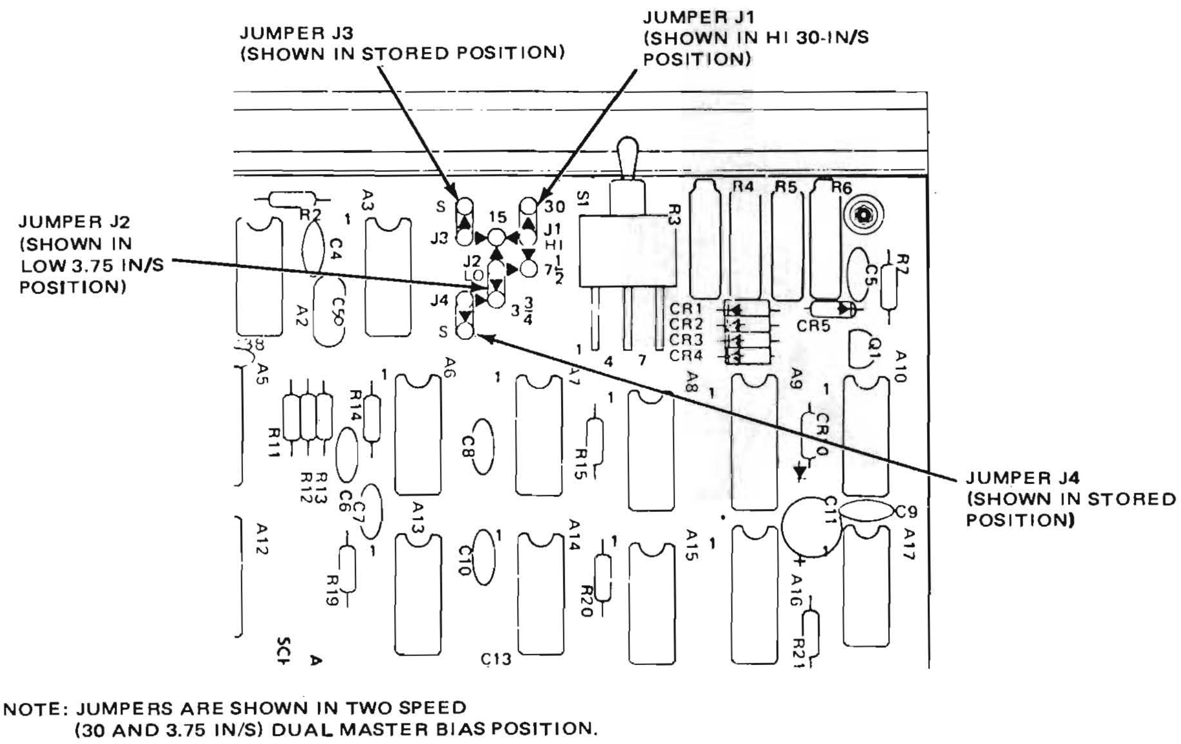



Figure 5-6. Speed/Bias Selection Jumpers, Audio Control PWA 5

adding or removing jumpers from terminals located on the input/output assembly module (Figure 5-7). Separate modification instructions are given for the input and output amplifier sections of the module.

**5-19. Input Amplifier.** To change the input amplifier operating configuration, proceed as follows:

**5-20.** *Increasing Input Sensitivity.* For a balanced input, input impedance of 25K ohms, and input sensitivity increased by 6 dB, perform the following modification.

1. Install a jumper between E16 and E17, and solder in place.
2. Install a jumper between E21 and E22, and solder in place.
3. Install capacitor C20 (47 pF, 5%, mica – customer-furnished) on the Input/Output Module PWA, and solder in place. Install the capacitor in circuit pad location designated on the Module PWA. (See note 6 on Input/Output Module PWA Schematic No. 4840421, and Figure 5-7.)

**5-21.** *Balanced or Unbalanced Input.* The input can be either balanced or unbalanced by the absence or presence of a jumper. For an unbalanced input, place a jumper between E24 and E25, and solder in place. For a balanced input, remove the jumper between E24 and E25.

**5-22.** *Bypassing Input Transformer.* If the input transformer is bypassed, the input will be unbalanced. Proceed as follows:

**NOTE**

**If either the input or output transformer is bypassed, the signal phase will shift 180°. However, if both transformers are bypassed, the overall phase will remain the same.**

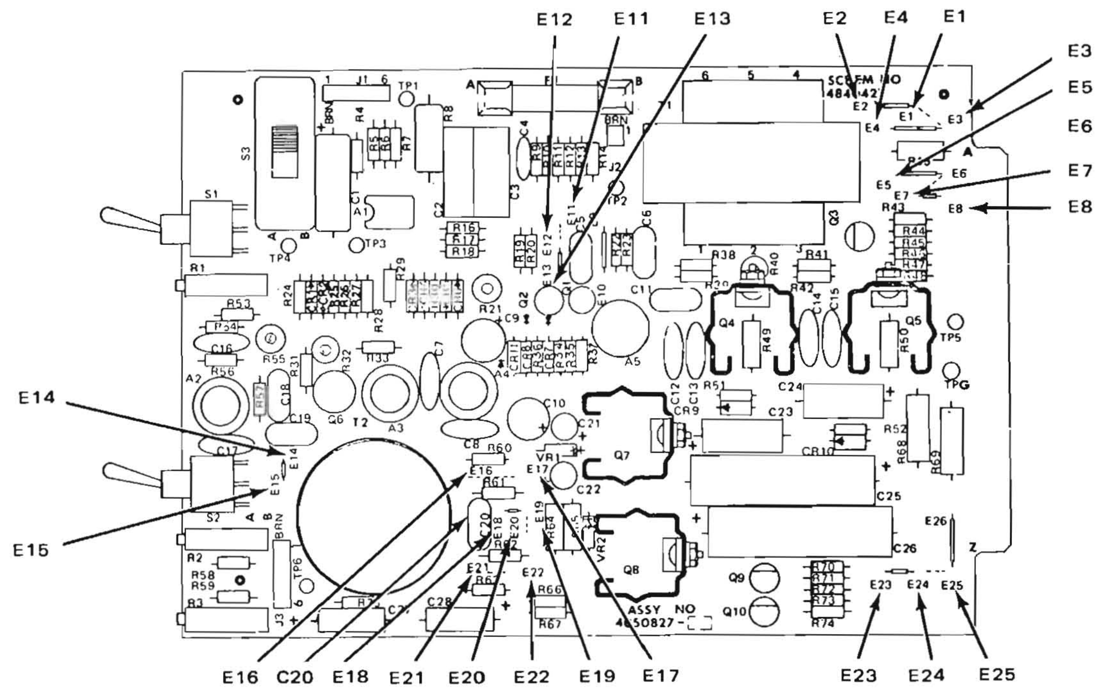



**Figure 5-7. Input/Output Assembly Module – Jumper Terminals and Capacitor C20**

1. Remove the following jumpers:

   E14 to E15
   E18 to E19
   E23 to E24

2. Add the following jumpers and solder in place:

   E24 to E25
   E19 to E20

3. After performing steps 1 and 2, the input impedance will be 25K ohms. To increase the gain by 6 dB and provide an input impedance of 12.7K ohms, install a jumper between E16 and E17 and solder in place.

5-23. *Shield Grounding.* The input connector (XLR type) is shipped from the factory with the shield grounded. If desired to have a "floating" shield, remove jumper between E25 and E26.

5-24. **Output Amplifier.** To change the putput amplifier operating configuration, proceed as follows:

5-25. *Balanced or Unbalanced Output.* The output can be either balanced or unbalanced by the absence or presence of a jumper. For an unbalanced output, place a jumper between E6 and E7 and solder in place. For a balanced output, remove the jumper between E6 and E7.

5-26. *Bypassing Output Transformer.* If the output transformer is bypassed, the output will be unbalanced. Proceed as follows:

**NOTE**

**If either the input or output transformer is bypassed, the signal phase will shift 180°. However, if both transformers are bypassed, the overall phase will remain the same.**

1. Remove the following jumpers:

   E12 to E13
   E1 to E2
   E3 to E4
   E5 to E6

2. Add the following jumpers and solder in place:

   E11 to E12
   E1 to E3
   E6 to E7

3. Change resistor R20 from 10K to 1.5K ohms, 1/4 watt.

4. Recalibrate the level meter as follows:

   a. Connect an audio oscillator to the line input connector (Figure 2-14).

   b. Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +4 dBm (or other operating level selected by the user).

   c. Set RECORD MANUAL/PRESET switch to PRESET position.

   d. Place input/output module on an extender board and insert board into mainframe.

   e. Apply power and place ATR-100 into input mode.

   f. Adjust meter calibration potentiometer R21 (Figure 5-18) for –6 (meter switch S3 in peak position) or 0 (meter switch S3 in vu position).

   g. With power off, remove input/output module and extender board from mainframe and reinstall input/output module into mainframe.

   h. Disconnect audio oscillator.

**5-27.** *Increasing Output Resistance with Balanced Output.* To increase the output resistance of the amplifier, install appropriate equal value resistors between E3 and E4 and between E5 and E6. For example, if a nominal output resistance of 600 ohms is desired, install 300-ohm resistors between E3 and E4 and between E5 and E6. Solder resistors in place.

**5-28.** *Shield Grounding.* The output connector (XLR type) is shipped from the factory with the shield grounded. If desired to have a "floating" shield, remove jumper from between E7 and E8.

## 5-29. ALIGNMENT AND ADJUSTMENTS

The following paragraphs contain information on the use of alignment tapes and flux loop, and head azimuth phase, and reproduce equalization adjustments.

### 5-30. Audio Signal System Alignment

The reproduce alignment procedure must be performed prior to the record alignment procedure. Reproduce alignment consists of setting low and high frequency equalization of each channel, adjusting reproduce head azimuth and phasing (multichannel systems), and setting operating level of each channel. Record alignment consists of setting bias level, setting record high frequency equalization, and setting system output level.

The alignment procedures are presented step-by-step in serial form for reproduce and record alignment of each channel. For the alignment of 2- or 4-channel systems, and after the reader has become familiar with the procedures, it may be more convenient to perform the steps in parallel for each channel.

The basic recorder/reproducer input and output level is set to –5 dBm, regardless of the actual operating level flux level selected for use. For maximum performance, the use of Ampex 456 tape with an operating level of 370 nWb/m is recommended. (This level is 6 dB higher than the 185-nWb/m reference level on Ampex Standard Alignment Tapes.) Procedures are included in this manual for setting the operating level to 185 nWb/m, 260 nWb/m, and 370 nWb/m.

When the basic recorder/reproducer is correctly adjusted, the Ampex input/output accessory or

any input/output assembly (either one correctly adjusted) can be connected to the recorder/reproducer without any adjustment.

NOTE

**All voltage levels are expressed in dB referenced to 0.775 volt rms across 600 ohms. Therefore a level of zero dBm corresponds to 0.775 volt rms.**

**5-31. Use of Alignment Tapes — General Discussion.** The alignment tapes have been precisely recorded and must be correctly handled and stored to retain their accuracy. The following requirements should be especially followed.

1. Clean and demagnetize the heads and other tape-handling components before using the test tape.
2. Never store test tapes in areas where there are temperature or humidity extremes or where magnetic fields may be present.
3. Remove test tapes from equipment only after a normal play or spool mode run (never after a fast-winding mode).

The test tape is threaded on the recorder/reproducer in the normal tape path (from the supply to the takeup reel). During alignment procedures, the rewind and fast forward modes may be used as necessary. After alignment, wind the tape completely on the takeup reel and then place the recorder/reproducer in the rewind spool mode to wind the tape back on its original reel. Note that after extensive use, high frequency tones on the alignment tape may drop as much as 2 dB, particularly at the slower tape speeds.

Operating level and reproduce frequency response can be checked with a standard alignment tape (Table 5-1). When using a standard alignment tape that is recorded the full width of the tape to check a system with heads less than full width, the response readings below approximately 10.0 kHz become progressively invalid as the frequency decreases. This is caused by the low-frequency fringing effect of the reproduce head. The reproduce head picks up additional flux beyond the track width of the head as the frequency decreases. This error, being wavelength dependent, becomes worse as the wavelength increases.

Therefore, if the equalization is correctly adjusted, the reproduce response when using a full-track alignment tape on either a 2-track, 1/4-inch tape system or a 4-track, 1/2-inch tape system should conform to the relative curves shown in Figure 5-8 within the tolerances given in Table 5-3. The curves given in Figure 5-8 display the *relative* fringing frequency response and *do not* include the fixed error due to the wider reproduce core width (as compared to the record head width).

Table 5-4 provides the amplitude correction factors to be used when setting operating level using a full-track alignment tape on a 2-track, 1/4-inch tape system or a 4-track, 1/2-inch tape system.

The correction factors in Table 5-4 are the amounts by which the actual measured reproduce output from a full width alignment tape will exceed the reproduce output of the correct track width recorded to the same fluxivity. The table includes the fixed error due to the wider reproduce core width and the relative fringing error (shown in Figure 5-8) for frequencies of 500 Hz, 700 Hz, and 1.0 kHz. For example, when reproducing the 700-Hz, 185 nWb/m tone on an Ampex 15 in/s full-width alignment tape on a 2-track, 1/4-inch tape system, the output (as read on an ac voltmeter) will be +1.14 dB higher (Table 5-4) as compared to reproducing and alignment tape that has the same track format as the recorder/reproducer.

The amplitude correction factor of 1.14 dB was obtained by adding the following figures:

0.56 dB – compensation for wide reproduce core width (see asterisk, Table 5-4).

0.58 dB – relative fringing frequency response due to fringing error effect at 700 Hz and 15 in/s (Figure 5-8).

1.14 dB – amplitude correction factor.

Table 5-3. Reproduce Frequency Response Tolerances

| SPEED | TOLERANCE ±0.5 dB | TOLERANCE ±1.5 dB | SEL SYNC ±2.0 dB |
|---|---|---|---|
| 30 in/s | 250 Hz – 20 kHz | 35 Hz – 250 Hz<br>20 kHz – 28 kHz | 50 Hz – 15 kHz |
| 15 in/s | 125 Hz – 15 kHz | 20 Hz – 125 Hz<br>15 kHz – 20 kHz | 40 Hz – 12 kHz |
| 7.5 in/s | 125 Hz – 10 kHz | 30 Hz – 125 Hz<br>10 kHz – 15 kHz | – |
| 3.75 in/s | 125 Hz – 5 kHz | 30 Hz – 125 Hz<br>5 kHz – 10 kHz | – |
| NOTE: To the above tolerances, add manufacturing tolerances of the alignment tape and relative fringing frequency response due to fringing effect (Figure 5-8). | | | |

Table 5-4. Amplitude Correction Factors for Setting Operating Level when using Full-Track Alignment Tapes on 2-Track or 4-Track Systems

| SPEED | REFERENCE FREQUENCY | CORRECTION FACTOR* | |
|---|---|---|---|
| | | 2 TRACK | 4 TRACK |
| 30 in/s | 500 Hz | +1.61 dB | +2.10 dB |
| | 700 Hz | +1.46 dB | +1.85 dB |
| | 1.0 kHz | +1.29 dB | +1.58 dB |
| 15 in/s | 500 Hz | +1.29 dB | +1.58 dB |
| | 700 Hz | +1.14 dB | +1.34 dB |
| | 1.0 kHz | +1.01 dB | +1.13 dB |
| 7.5 in/s | 500 Hz | +1.01 dB | +1.13 dB |
| | 700 Hz | +0.90 dB | +0.99 dB |
| | 1.0 kHz | +0.81 dB | +0.87 dB |
| 3.75 in/s | 500 Hz | +0.81 dB | +0.87 dB |
| | 700 Hz | +0.74 dB | +0.79 dB |
| | 1.0 kHz | +0.69 dB | +0.74 dB |

*The amplitude correction factors shown in the table are the sum of the values shown in Figure 5-8 for the frequencies shown in the table, and the fixed errors due to wider reproduce core width as follows:

2 track – 0.56 dB due to 80-mil reproduce core on 75-mil track
4 track – 0.6 dB due to 75-mil reproduce core on 70-mil track

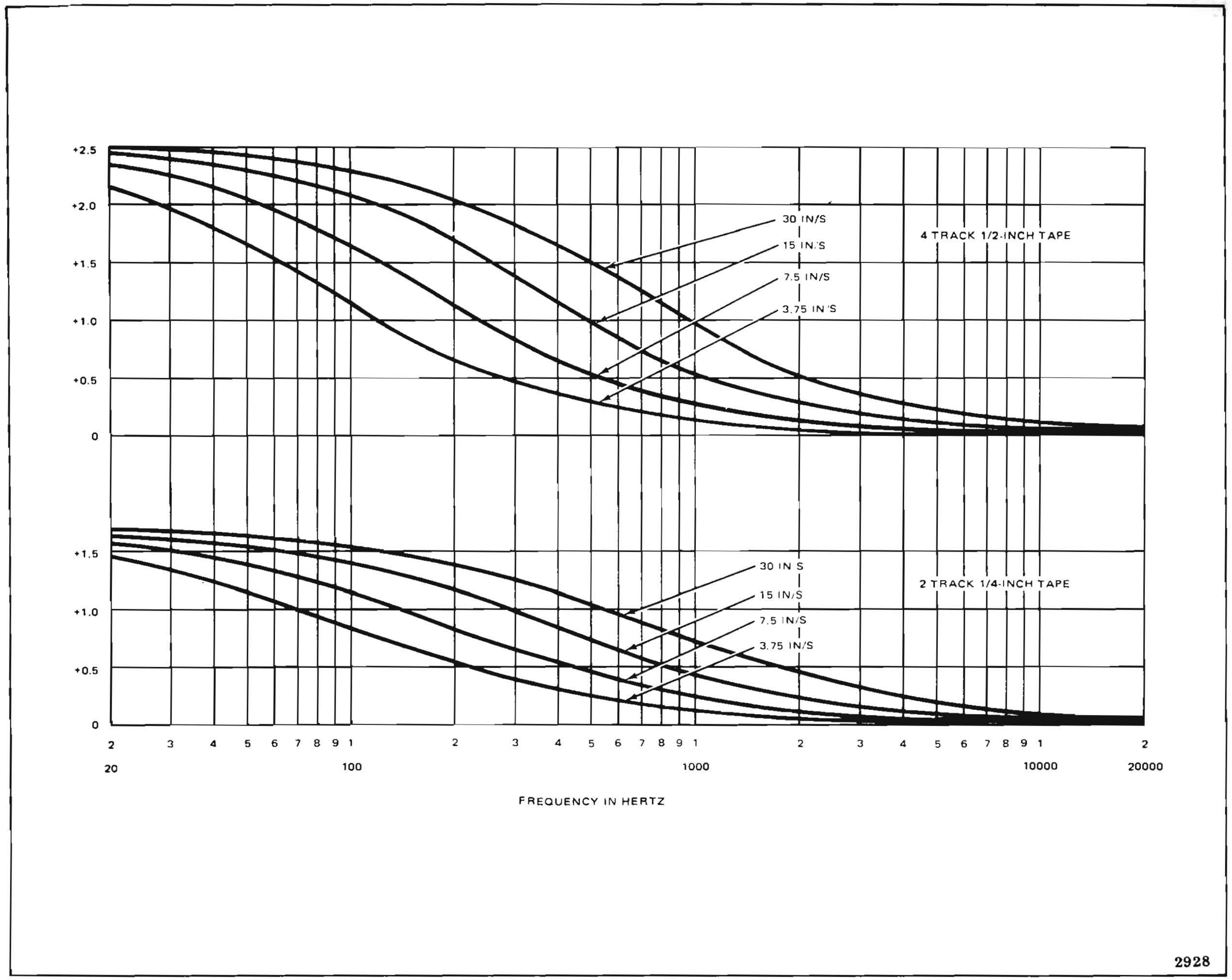



Figure 5-8. Relative Fringing Frequency Response Due to Fringing Effect

Note that if the alignment tape used matches the head track format, the correction factors given in Table 5-4 are not used. Also no corrections are required when using a full-width alignment tape to align a full-track head assembly system.

Another source of error is the reproduce head pole contour effect. This effect is prevalent when using the low-frequency sections of the alignment tape. If the alignment tape track format matches the reproduce head format, the error is not severe. This type of error can be minimized by adjustment of the low frequency reproduce equalizers while performing the overall record/reproduce alignment procedure.

**5-32. Using a Flux Loop — General Discussion.** An accurate method of setting equalization involves the use of a flux loop driven by an audio oscillator in order to induce an electromagnetic field into the reproduce head. The field produced by the flux loop may be equalized to simulate the short circuit flux/frequency response from an ideally recorded alignment tape. The response of a correctly equalized reproduce system to a correctly equalized flux loop will be an almost constant output with frequency over the audio range of interest. However, the use of the flux loop will not disclose the following errors:

- Reproduce head low frequency pole contour and secondary gap effect.
- Reproduce head high frequency gap loss.
- Effects due to head-to-tape contact or azimuth errors.

The ATR-100 incorporates automatically selected preset equalization to correct for secondary gap rise at 15 and 30 in/s. Therefore, at 15 and 30 in/s, with the reproduce low frequency and high frequency equalizer controls correctly set, the actual flux-looped low-frequency response will depart from a flat response by a specific amount depending on frequency. Figure 5-9 shows the correct response that should be obtained at 15 and 30 in/s with the reproduce equalizers adjusted to match the equalization standard set on the equalized flux loop. The output frequency response using a correctly equalized flux loop should be flat for 3.75 and 7.5 in/s.

A recommended flux loop for use with the ATR-100 is the Ampex flux loop (Ampex Part No. 4020423) used with an Ampex flux loop equalizing amplifier (Ampex Part No. 4040424). This equalizing amplifier contains inverse compensation for the secondary gap rise for the setting of equalization at 15 and 30 in/s. Therefore, Figure 5-9 does not apply when using the Ampex equalizing amplifier.

When an equalizing amplifier is not used, the flux loop may be passively equalized by use of a capacitor connected across the oscillator terminals, to provide the high-frequency transition. Table 5-5 provides capacitor values for specified equalization standards when using an audio oscillator with 600 ohms output and an Ampex flux loop that has a dc resistance of 100 ohms. If a flux loop or audio oscillator with other characteristics is used, a nominal capacitor value may be calculated by the following formula:

$$C = \frac{T(R_0 + R_1)}{R_0 \cdot R_1}$$

Where:

$T$ = equalization transition time constant (seconds) (Table 5-5)

$R_0$ = oscillator output resistance (ohms)

$R_1$ = flux loop dc resistance (ohms)

$C$ = capacity in $\mu$F

Figure 5-10 shows the desired system response from an unequalized flux loop, with constant current drive, for the most common equalization standards.

**5-33. Head Azimuth and Phase — General Discussion.** The only head adjustment required is for record and reproduce head stack azimuth. Precision mounting of the record and reproduce head stack has eliminated the need for adjusting tape wrap, height, and zenith. The azimuth adjustment is made by turning a hex socket screw accessible through the top of the head shield (Figure 5-11) which causes a tapered gear to rotate underneath the head-stack precision plate. The azimuth adjustment is adjustable over a range of ± 15 minutes of arc.

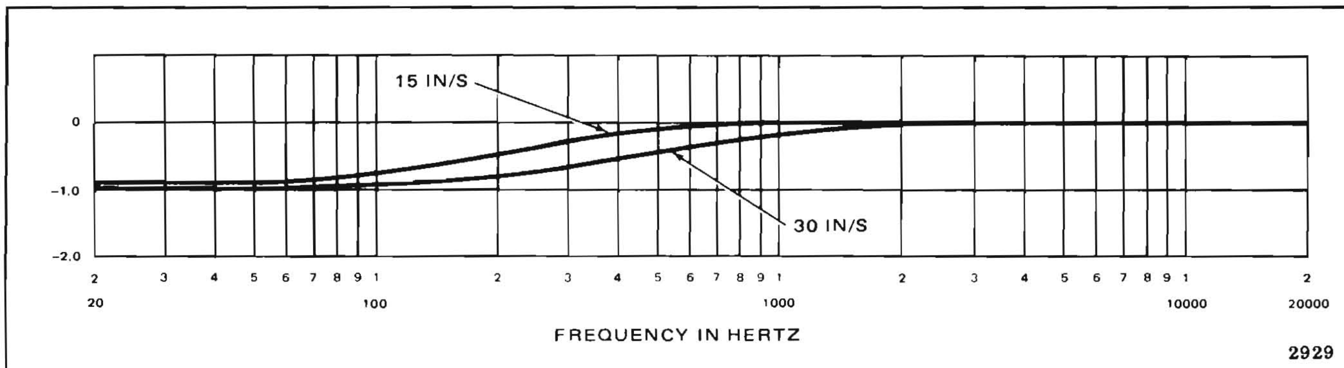



**Figure 5-9. Equalized Flux Loop Response for 15 in/s and 30 in/s**

Table 5-5. Capacitor Values for Passive Equalization of High Frequency Turnover

| TAPE SPEED AND EQUALIZATION STANDARD | HIGH FREQUENCY TRANSITION TIME CONSTANT | −3 dB FREQUENCY | CAPACITOR VALUE* |
|---|---|---|---|
| 30 in/s AES | 17.5 $\mu$s | 9,095 Hz | 0.204 $\mu$F |
| 15 in/s IEC/CCIR | 35 $\mu$s | 4,547 Hz | 0.408 $\mu$F |
| 7.5/15 in/s NAB | 50 $\mu$s | 3,183 Hz | 0.583 $\mu$F |
| 7.5 in/s IEC/CCIR | 70 $\mu$s | 2,274 Hz | 0.817 $\mu$F |
| 3.75 in/s | 90 $\mu$s | 1,768 Hz | 1.05 $\mu$F |

*Capacitor value when using audio oscillator with 600-ohm output impedance and Ampex flux loop, part number 4020423-01 ($R_{loop}$ = 100 ohms).

The adjustment of head phase can be considered a fine adjustment of head azimuth and is adjusted to eliminate phase error between tracks of a 2-track or 4-track head assembly. Prior to the adjustment of head phase, the following criteria should be met:

1. Reproduce head — Reproduce equalization is correct.

2. Record head — Reproduce equalization and reproduce head azimuth have been adjusted. Record equalization and bias have been set for overall system high-frequency response and azimuth adjusted for maximum short wave output.

Failure to observe the above criteria can result in incorrect mechanical azimuth being set in order to compensate for inter-track phasing errors. These errors are electrical in origin (differences between tracks in reproduce equalization, record equalization and/or record bias).

**5-34. Operating Level — General Discussion.** The operating level used is a matter of individual preference by the user of the recorder/reproducer. However, the use of Ampex 456 tape (or direct equivalent) with an operating level of 370 nWb/m is recommended. This level will provide the lowest distortion and adequate headroom prior to tape saturation. Use of Ampex 456 tape with a lower operating level will degrade signal-to-noise ratio but will lower distortion and increase headroom.

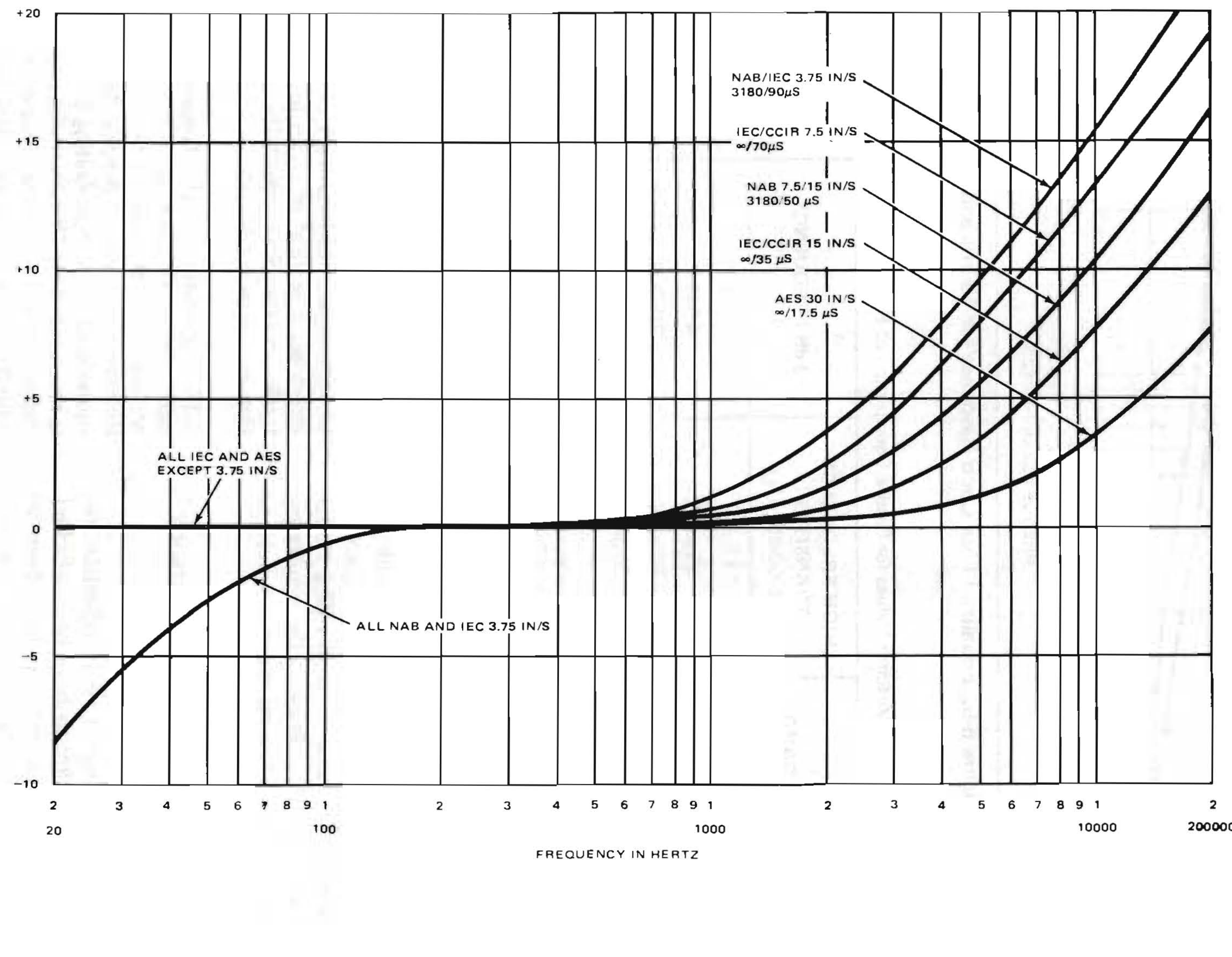



Figure 5-10. Reproduce Response from Unequalized Flux Loop

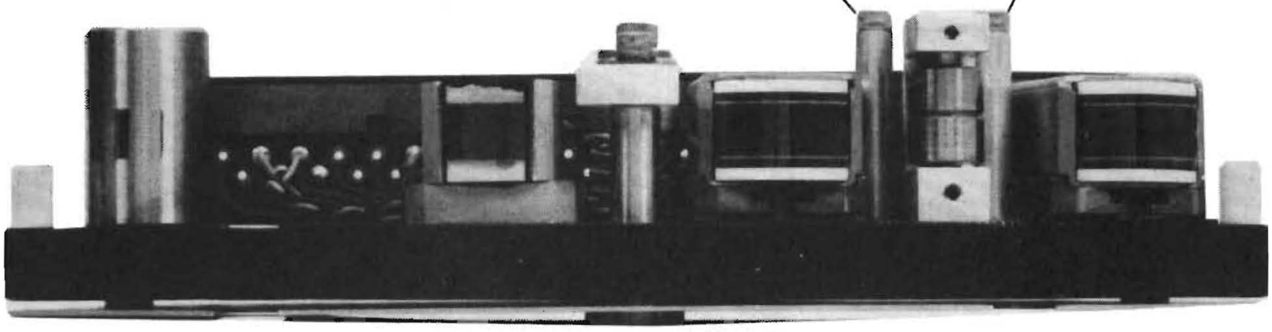



**Figure 5-11. Azimuth Adjustment Screw Location**

With other types of tape, other operating levels may be preferable. For example, when using Ampex 406/407 tape, an operating level of not more than 260 nWb/m is recommended.

Operating level is set while reproducing a standard alignment tape of known short circuit fluxivity, and adjusting the recorder/reproducer reproduce gain appropriately. In the case of the Ampex alignment tapes, reference levels of 700 Hz (500 Hz at 3.75 in/s) at 185 nWb/m are used. (Other manufacturers of alignment tapes have standard reference levels at 200 nWb/m or 250 nWb/m at 1.0 kHz, or 320 nWb/m at 1.0 kHz.) Table 5-6 shows the relative differences in level between Ampex reference level (185 nWb/m) and other reference levels in domestic and international use.

If a full width alignment tape is used to set reproduce gain on a 2- or 4-track system, errors in absolute reproduce sensitivity to recorded fluxivity will result due to the fringing effect. This error becomes more pronounced at the higher tape speeds. Table 5-4 lists the correction factors to be applied when using a full-width alignment tape for setting reference level when using a 2-track or 4-track reproduce head assembly.

The correction factors in Table 5-4 are the amounts by which the actual measured reproduce output from a full-width alignment tape will exceed the reproduce output of the correct track width recorded to the same fluxivity. For example, when reproducing the 700-Hz, 185-nWb/m tone of an Ampex 15 in/s full-width alignment tape on a 2-track, 1/4-inch head assembly, the reproduce gain is set to provide 1.14 dB higher output than actually required. This correction factor provided in Table 5-4 also compensates for the wider-than-normal core head used on the ATR-100. The wider reproduce core minimizes level errors when reproducing tape recorded on other machines with head heights set incorrectly.

Note that if the alignment tape used matches the head track format, the correction factors given in Table 5-4 are not used. Also no corrections are required when using a full-width alignment tape to align a full-track head system.

**5-35. Reproduce Equalization Adjustment.** Reproduce equalization adjustment consists of setting the low and high frequency equalization of each audio channel, utilizing a standard alignment tape or a flux loop. The more accurate method of

Table 5-6. Relative Operating Levels

| DESCRIPTION | RELATIVE LEVEL | SHORT CIRCUIT FLUXIVITY | FREQUENCY |
|---|---|---|---|
| Ampex reference level (standard operating level) | 0 dB | 185 nWb/m | 700 Hz or 500 Hz |
| Other U.S. reference levels | +0.7 dB | 200 nWb/m | 1.0 kHz |
| Elevated operating level | +3 dB | 250/260 nWb/m | 1.0 kHz |
| IEC reference level | +4.8 dB | 320 nWb/m | 1.0 kHz |
| Recommended operating level for ATR-100 and 456 tape | +6 dB | 370 nWb/m | 700 Hz |

setting equalization involves the use of a flux loop driven by an audio oscillator to induce a flux into the reproduce head. Both methods of setting equalization are given in the procedures. Prior to performing the alignment procedure, refer to the general discussion regarding the use of flux loops, paragraph 5-32.

NOTE

**Where input and output line levels pertaining to the input/output assembly are stated, it is assumed that the input/output assembly has been set to the factory-adjusted input and output line level of +4-dBm operating level (0 vu). If another value line input and output operating level is being used, the levels stated in the adjustment procedures should be amended by the amount of deviation from the +4-dBm operating level.**

CAUTION

TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS ON A PRINTED WIRING ASSEMBLY (PWA), ALWAYS TURN RECORDER/REPRODUCER POWER OFF BEFORE REMOVING OR INSTALLING A PWA IN THE RECORDER/REPRODUCER OR INPUT/OUTPUT ASSEMBLY.

5-36. *Equalization Adjustment on the 2-Speed PADNET Using an Alignment Tape.* The procedure assumes use of an Ampex alignment tape. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of the manual, paragraphs 5-4 and 5-7.

2. Remove Main Audio PWA from electronics assembly corresponding to channel being adjusted.

3. Set control R34 (Figure 5-12) to midrange. Reinstall PWA.

4. Set REPR GAIN control R1 on PADNET PWA (Table 5-7) to full clockwise position.

5. Connect ac voltmeter to one of the following output connectors.

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

   b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).

6. Select appropriate system tape speed at the transport control panel.

7. Thread appropriate alignment tape (Table 5-1) on the transport and place system in thread mode.

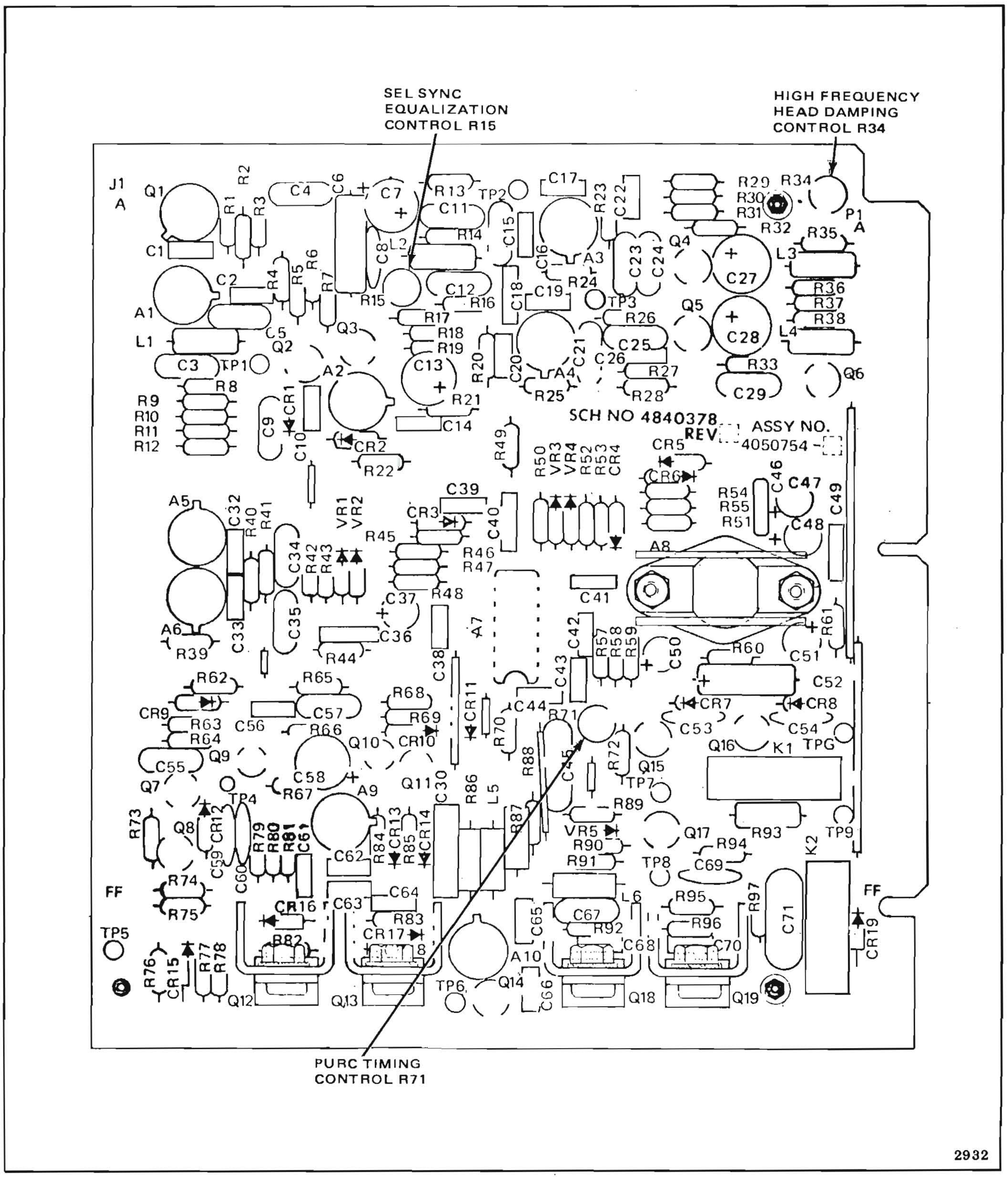



Figure 5-12. Main Audio PWA 1, 2, 3, or 4 – Alignment Controls

NOTE

**If a full-track alignment tape is used to adjust a multitrack system, it will be necessary to correct for the fringing effect. Refer to fringing effect discussion given under** *Use of Alignment Tapes,* paragraph 5-31.

8. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

9. Place system in play mode and establish reference frequency level as follows:

   a. 3.75 in/s – Set REPR GAIN control so that ac voltmeter reads –15 dBm at the 500-Hz reference tone (–10 dB below 185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or –6 dBm at the output of the input/output assembly.

   b. 7.5 in/s – Set REPR GAIN control so that ac voltmeter reads –15 dBm at the 700-Hz reference tone (–10 dB below 185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or –6 dBm at the output of the input/output assembly.

   c. 15 or 30 in/s – Set REPR GAIN control so that ac voltmeter reads –5 dBm at the 700-Hz reference tone (185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

10. While reproducing the highest frequency tone on the alignment tape (7.5 kHz at 3.75 in/s or 15 kHz at 7.5, 15, and 30 in/s), adjust the reproduce head azimuth screw (Figure 5-11) for maximum output.

11. While reproducing the 10.0-kHz tone (7.50 kHz at 3.75 in/s), adjust appropriate reproduce equalizer control (HI SPEED HF or LO SPEED HF) on PADNET (Table 5-7) for the same level obtained in step 9 (or to required relative level as indicated in Figure 5-8, if applicable).

12. While reproducing the 50-Hz tone, adjust appropriate reproduce equalizer control (HI SPEED LF or LO SPEED LF) on PADNET for the same level obtained in step 9. (Note: This is an approximate setting, final adjustment will be made during an overall record/reproduce alignment procedure.)

13. Reproduce the frequency response test tones on the alignment tape. Reproduce response should conform to tolerances shown in Table 5-3. If applicable, refer to relative fringing error curves shown in Figure 5-8.

14. Repeat steps 2 through 13 for other audio channels to be adjusted.

15. Adjust operating level by following instructions given starting with paragraph 5-43.

NOTE

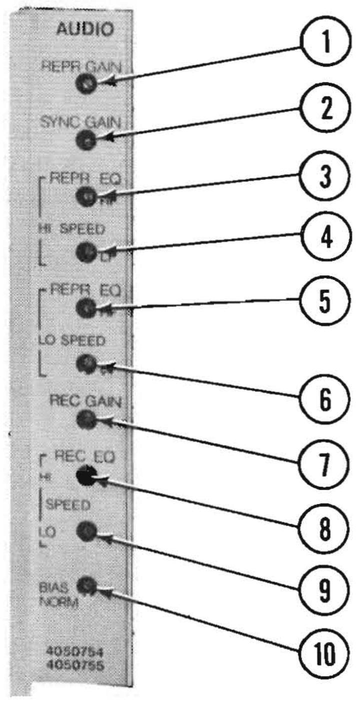
**Final adjustment of the reproduce low frequency equalizers for optimum low-frequency response will be accomplished during an overall record/reproduce alignment procedure given later in this section of the manual.**

**5-37.** *Equalization Adjustment on the 4-Speed PADNET Using an Alignment Tape.* The procedure assumes use of an Ampex alignment tape. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of the manual, paragraphs 5-4 and 5-7.

2. Remove Main Audio PWA from electronics assembly corresponding to channel being adjusted.

Table 5-7. 2-Speed PADNET PWA — Alignment Controls

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| INDEX NO. | CONTROL | FUNCTION |
|---|---|---|
| 1 | REPR GAIN (R1) | Adjusts basic recorder/reproducer interface reproduce level. |
| 2 | SYNC GAIN (R3) | Adjusts basic recorder/reproducer sel sync reproduce interface level. |
| 3 | HI SPEED HF (R5) | Adjusts high-speed, high-frequency reproduce equalization. |
| 4 | HI SPEED LF (R7) | Adjusts high-speed, low-frequency reproduce equalization. |
| 5 | LO SPEED HF (R9) | Adjusts low-speed, high-frequency reproduce equalization. |
| 6 | LO SPEED LF (R11) | Adjusts low-speed, low-frequency reproduce equalization. |
| 7 | REC GAIN (R12) | Adjusts basic recorder/reproducer interface record level. |
| 8 | HI SPEED (R15) | Adjusts high-speed, high-frequency record equalization. |
| 9 | LO SPEED (R18) | Adjusts low-speed, high-frequency record equalization. |
| 10 | BIAS NORM (R21) | Normalizes bias level for individual channel to common master bias bus level. |

3. Set control R34 (Figure 5-12) to midrange. Reinstall PWA.

4. Set all REPRO GAIN controls (R23, R24, R25, and R26) on PADNET PWA (Table 5-8) to full clockwise position.

5. Connect ac voltmeter to one of the following output connectors.

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13

Table 5-8. Reproduce Tape Speed Adjustments

| TAPE SPEED | REPRO GAIN | REPRO EQ HF | REPRO EQ LF |
|---|---|---|---|
| 30 | R26 | R22 | R18 |
| 15 | R25 | R21 | R17 |
| 7.5 | R24 | R20 | R16 |
| 3.75 | R23 | R19 | R15 |

or J14 (Figure 2-13 and Tables 2-2 and 2-3).

b. If an input/output is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).

6. Select appropriate system tape speed at the transport control panel.

7. Thread appropriate alignment tape (Table 5-1) on the transport and place system in thread mode.

NOTE

**If a full-track alignment tape is used to adjust a multitrack system, it will be necessary to correct for the fringing effect. Refer to fringing effect discussion given under *Use of Alignment Tapes,* paragraph 5-31.**

8. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

9. Place system in play mode and establish reference frequency as follows: (see Figure 5-13).

a. 3.75 in/s – Set REPRO GAIN 3.75 control so that ac voltmeter reads –15 dBm at the

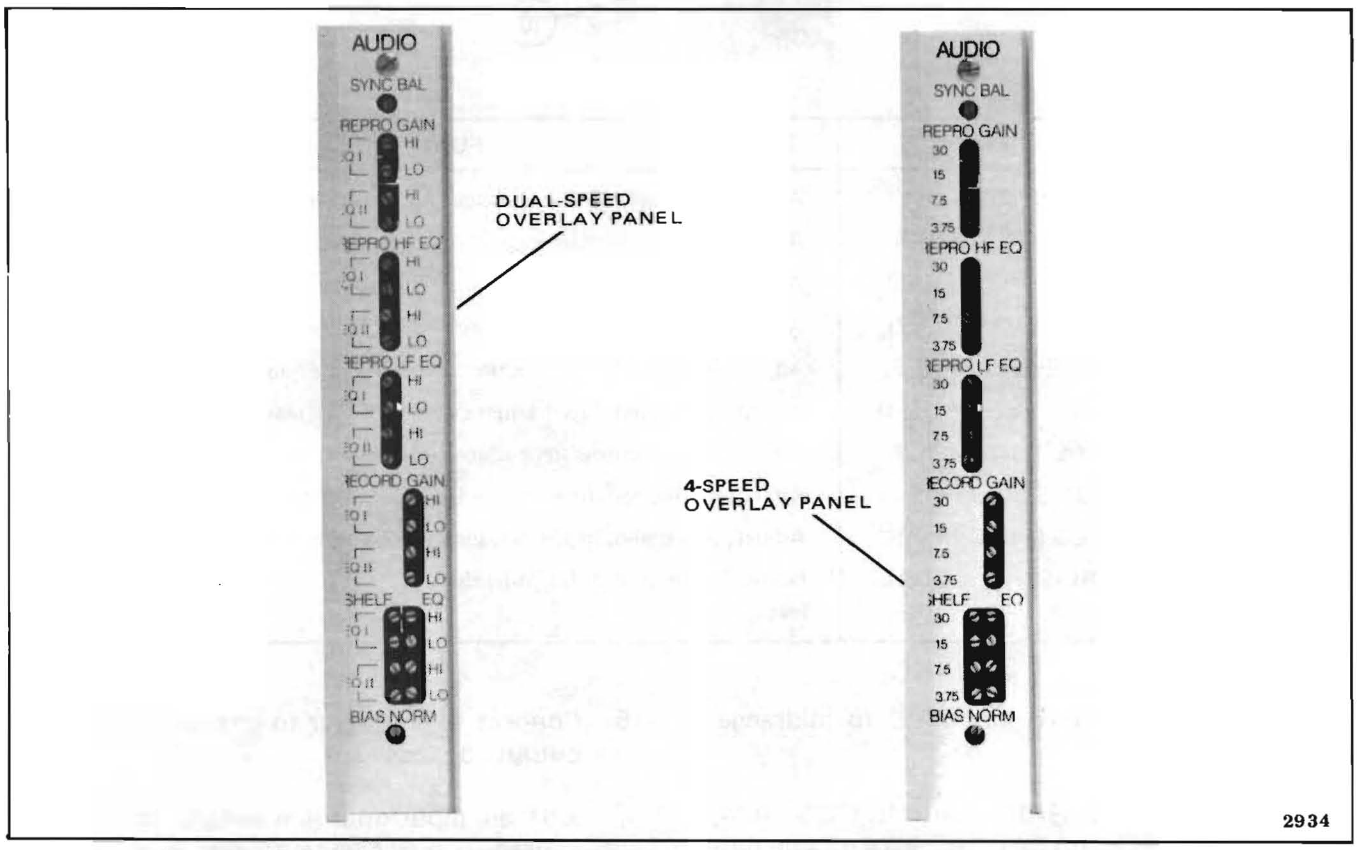



Figure 5-13. Overlay Panels, Main Audio PWA Nos. 1, 2, 3, and 4 for Use with 4-Speed PADNET

500-Hz reference tone (–10 dB below 185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or –6 dBm at the output of the input/output assembly.

b. 7.5 in/s – Set REPRO GAIN 7.5 control so that ac voltmeter reads –15 dBm at the 700-Hz reference tone (–10 dB below 185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or –6 dBm at the output of the input/output assembly.

c. 15 in/s – Set REPRO GAIN 15 control so that ac voltmeter reads –5 dBm at the 700-Hz reference tone (185 nWb/m, first tone on tape) at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

d. 30 in/s – Set REPRO GAIN 30 control so that ac voltmeter reads –5 dBm at the 700-Hz reference tone (185 nWb/m first tone on tape) at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

10. While reproducing the highest frequency tone on the alignment tape (7.5 kHz at 3.75 in/s or 15 kHz at 7.5, 15, and 30 in/s), adjust the reproduce head azimuth screw (Figure 5-11) for maximum output.

11. While reproducing the 10.0-kHz tone (7.50 kHz at 3.75 in/s), adjust appropriate REPRO EQ control R19, R20, R21, or R22 (HF) or R15, R16, R17 or R18 (LF) (see Table 5-8) on PADNET (Table 5-9) for the same level obtained in step 9 (or to required relative level as indicated in Figure 5-8, if applicable).

12. While reproducing the 50-Hz tone, adjust appropriate reproduce equalizer control R19, R20, R21 or R22 (HF) or R15, R16, R17 or R18 (LF) on PADNET for the same level obtained in step 9. (Note: This is an approximate setting, final adjustment will be made during an overall record/reproduce alignment procedure.)

13. Reproduce the frequency response test tones on the alignment tape. Reproduce response should conform to tolerances shown in Table 5-3. If applicable, refer to relative fringing error curves shown in Figure 5-8.

14. Repeat steps 2 through 13 for other audio channels to be adjusted.

15. Adjust operating level by following instructions given starting with paragraph 5-43.

NOTE

**Final adjustment of the reproduce low frequency equalizers for optimum low-frequency response will be accomplished during an overall record/reproduce alignment procedure given later in this section of the manual.**

**5-38.** *Reproduce Equalization Adjustment on the 2-Speed PADNET Using a Flux Loop.* A flux loop is used to induce an electromagnetic field into the reproduce head for the purpose of adjusting reproduce equalization. Prior to performing the alignment procedure, refer to the general discussion concerning the use of flux loops, paragraph 5-32. Proceed as follows:

1. With system power off, remove Main Audio PWA from electronics assembly corresponding to channel being adjusted.

2. Set control R34 (Figure 5-12) to midrange. Reinstall PWA.

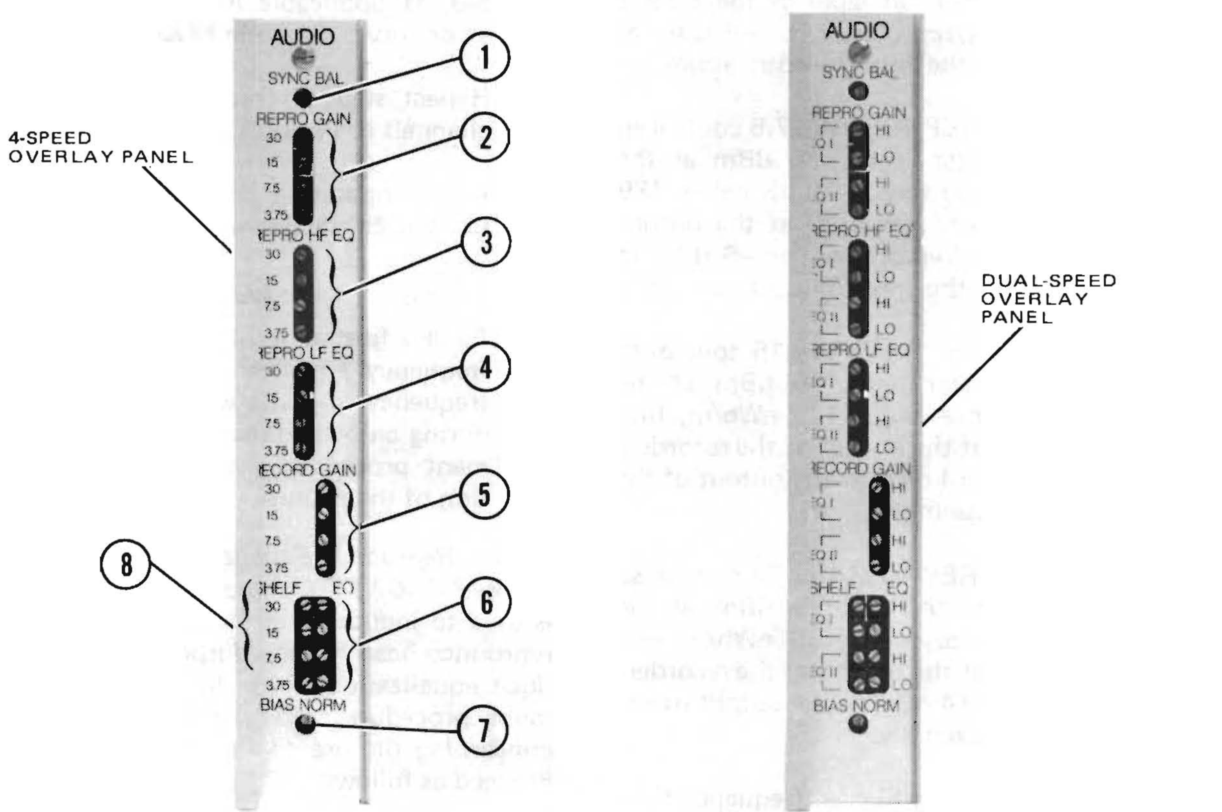
3. Select appropriate system tape speed at the transport control panel.

4. Clip flux loop to reproduce head.

5. If a flux loop equalizing amplifier is being used (Table 5-1), select the appropriate equalization time constant on the amplifier and connect amplifier to audio oscillator. Observe that amplifier is not overdriven so as to cause clipping, particularly of low-frequency signals.

6. If a flux loop equalizing amplifier is not being used, connect an appropriate equalizing capacitor (Table 5-5) across audio oscillator terminals and connect flux loop (Ampex Part No. 4020423) to the oscillator.

**Table 5-9. 4-Speed PADNET PWA – Alignment Controls**




| INDEX NO. | CONTROL | FUNCTION |
|---|---|---|
| 1 | SYNC BALANCE (R27) | Adjusts basic recorder/reproducer sel sync reproduce interface level. |
| 2 | 30 REPRO GAIN (R26)<br>15 REPRO GAIN (R25)<br>7.5 REPRO GAIN (R24)<br>3.75 REPRO GAIN (R23) | Adjusts recorder/reproducer interface reproduce level for selected tape speed. |
| 3 | 30 REPRO HF EQ (R22)<br>15 REPRO HF EQ (R21)<br>7.5 REPRO HF EQ (R20)<br>3.75 REPRO HF EQ (R19) | Adjusts high-frequency reproduce equalization for selected tape speed. |
| 4 | 30 REPRO LF EQ (R18)<br>15 REPRO LF EQ (R17)<br>7.5 REPRO LF EQ (R16)<br>3.75 REPRO LF EQ (R15) | Adjusts low-frequency reproduce equalization for selected tape speed. |
| 5 | 30 REC GAIN (R48)<br>15 REC GAIN (R49)<br>7.5 REC GAIN (R50)<br>3.75 REC GAIN (R51) | Adjusts recorder/reproducer interface record level for selected tape speed. |

Table 5-9. 4-Speed PADNET PWA – Alignment Controls (Continued)

| INDEX NO. | CONTROL | FUNCTION |
|---|---|---|
| 6 | 30 EQ (R52)<br>15 EQ (R53)<br>7.5 EQ (R54)<br>3.75 EQ (R55) | Adjusts record equalization for selected tape speed. |
| 7 | BIAS NORM (R1) | Normalizes bias level for individual channel to common master bias bus level. |
| 8 | 30 SHELF (R6)<br>15 SHELF (R5)<br>7.5 SHELF (R4)<br>3.75 SHELF (R3) | Adjusts record shelfing on all selected tape speeds. |
| NOTE: | (1) When dual speed overlay is installed reference designations of controls will remain the same.<br>(2) EQ I HI/LO refers to speed selected in configuration 2 with bias switch in the I position.<br>(3) EQ II HI/LO is similar to EQ I except the bias switch will be in the EQ II position. | |

7. Set oscillator to +4 dBm output at 1.0 kHz.
8. Connect ac voltmeter to one of the following output connectors:
   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 and J14 (Figure 2-13 and Tables 2-2 and 2-3).
   b. If an input/output assembly is being used, connect ac voltmeter to appropriate recorder/reproducer output connector (Figures 2-14 and 2-15).
9. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.
10. Apply system power and set REPR GAIN control so that ac voltmeter reads –20 dBm at the output of the recorder/reproducer, or –10 dBm at the output of the input/output assembly.
11. Change oscillator frequency to 15.0 kHz.
12. Adjust appropriate reproduce equalizer control (HI SPEED HF or LOW SPEED HF) on PADNET for the same level obtained in step 10.
13. Sweep oscillator through frequency range of 10 kHz to 20 kHz. The response should be within ±0.25 dB of the level at 10 kHz. If not, remove power and make slight adjustment of R34 on Main Audio PWA. Reinstall PWA and apply power.
14. Repeat step 13 as necessary to achieve the desired results.
15. Change oscillator frequency to 30 Hz.
16. Adjust appropriate reproduce equalizer control (HI SPEED LF or LOW SPEED LF) on PADNET for same level obtained in step 10 for 3.75 in/s or 7.5 in/s, or for level to conform to response curves in Figure 5-9 for 15 in/s or 30 in/s.

NOTE

**The Ampex flux loop equalizing amolifier contains compensation for secondary gap rise. Therefore the equalizer control should be set for flat response and reference to Figure 5-9 is not required.**

17. Sweep oscillator through frequency range of 20 Hz to 20 kHz. For speeds 3.75 in/s and 7.5 in/s, response should be flat ±0.25 dB. For

speeds 15 in/s and 30 in/s, response should match curves in Figure 5-9 within ±0.25 dB.

18. Repeat steps 1 through 17 for the other audio channels to be adjusted.

NOTE

**Final adjustment of the reproduce low-frequency equalizers for optimum low-frequency response will be accomplished during an overall record/reproduce alignment procedure given later in this section of the manual.**

**5-39.** *Reproduce Equalization Adjustment on the 4-Speed PADNET Using a Flux Loop.* A flux loop is used to induce an electromagnetic field into the reproduce head for the purpose of adjusting reproduce equalization. Prior to performing the alignment procedure, refer to the general discussion concerning the use of flux loops, paragraph 5-32. Proceed as follows:

1. With system power off, remove Main Audio PWA from electronics assembly corresponding to channel being adjusted.
2. Set control R34 (Figure 5-12) to midrange. Reinstall PWA.
3. Select appropriate system tape speed at the transport control panel.
4. Clip flux loop to reproduce head.
5. If a flux loop equalizing amplifier is being used (Table 5-1), select the appropriate equalization time constant on the amplifier and connect amplifier to audio oscillator. Observe that amplifier is not overdriven so as to cause clipping, particularly of low-frequency signals.
6. If a flux loop equalizing amplifier is not being used, connect an appropriate equalizing capacitor (Table 5-5) across audio oscillator terminals and connect flux loop (Ampex Part No. 4020423) to the oscillator.
7. Set oscillator to +4 dBm output at 1.0 kHz.
8. Connect ac voltmeter to one of the following output connectors:
   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 and J14 (Figure 2-13 and Tables 2-2 and 2-3).
   b. If an input/output assembly is being used, connect ac voltmeter to appropriate recorder/reproducer output connector (Figures 2-14 and 2-15).
9. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

NOTE

**Refer to Table 5-8 for proper PADNET controls to be adjusted at selected tape speed.**

10. Apply system power and set appropriate REPRO GAIN control R23, R24, R25, or R26 so that ac voltmeter reads –20 dBm at the output of the recorder/reproducer, or –10 dBm at the output of the input/output assembly.
11. Change oscillator frequency to 15.0 kHz.
12. Adjust appropriate reproduce equalizer control R19, R20, R21, or R22 (REPRO HF EQ) or R15, R16, R17 or R18 (REPRO LF EQ) on PADNET for the same level obtained in step 10.
13. Sweep oscillator through frequency range of 10 kHz to 20 kHz. The response should be within ±0.25 dB of the level at 10 kHz. If not, remove power and make slight adjustment of R34 on Main Audio PWA. Reinstall PWA and apply power.
14. Repeat step 13 as necessary to achieve the desired results.
15. Change oscillator frequency to 30 Hz.
16. Adjust appropriate reproduce equalizer control R19, R20, R21, or R22 (REPRO HF EQ) or R15, R16, R17, or R18 (REPRO LF EQ)

on PADNET for same level obtained in step 10 for 3.75 in/s or 7.5 in/s, or for level to conform to response curves in Figure 5-9 for 15 in/s or 30 in/s.

NOTE

**The Ampex flux loop equalizing amplifier contains compensation for secondary gap rise. Therefore the equalizer control should be set for flat response and reference to Figure 5-9 is not required.**

17. Sweep oscillator through frequency range of 20 Hz to 20 kHz. For speeds 3.75 in/s and 7.5 in/s, response should be flat ±0.25 dB. For speeds 15 in/s and 30 in/s, response should match curves in Figure 5-9 within ±0.25 dB.
18. Repeat steps 10 through 17 for each tape speed.
19. Repeat steps 1 through 17 for the other audio channels to be adjusted.

**5-40. Reproduce Head Azimuth and Phase Adjustment.** The adjustment of head phase can be considered a fine adjustment of head azimuth and is adjusted to eliminate phase error between tracks of a 2-track or 4-track head assembly. Prior to performing the alignment procedure, refer to the general discussion concerning head azimuth and phase adjustment, paragraph 5-33.

**5-41.** *2-Track or 4-Track Reproduce Head Azimuth and Phase Adjustment.* Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance,* paragraphs 5-4 and 5-7.
2. As a preliminary adjustment, turn reproduce head azimuth adjusting screw (Figure 5-11) so that reference hole in tapered gear is in front of the head-gap region.
3. Connect a dual trace scope as follows:

   NOTE

   **If a dual trace scope is not available, proceed to step 4.**

   a. For a 2-track head assembly system, connect scope to channel 1 and channel 2 outputs of the recorder system.

   b. For a 4-track head assembly system, connect scope to channel 1 and channel 4 outputs of the recorder system.

   c. Trigger scope from recorder channel 1 output.

   d. Proceed to step 5.

4. If a dual trace scope is not available, connect a single channel scope to display a Lissajou pattern as follows:

   a. For a 2-track head assembly system, connect channel 1 output to the vertical input of scope, and connect channel 2 output to the horizontal input of the scope.

   b. For a 4-track head assembly system, connect channel 1 output to the vertical input of scope, and connect channel 4 output to the horizontal input of the scope.

5. Thread appropriate alignment tape (Table 5-1) on the transport and place system in thread mode.
6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust reproduce head azimuth adjusting screw to obtain minimum phase error as viewed on scope (or Lissajou pattern straight line at 45° ).
7. Minimize average phase error by carefully adjusting the head azimuth adjusting screw while playing back one of the following higher frequency test tones on the alignment tape.

   a. 30 in/s — 15 kHz

   b. 15 in/s — 10 kHz

   c. 7.5 in/s — 5.0 kHz

   d. 3.75 in/s — 2.5 kHz

NOTE

**The frequencies given in step 7 were chosen to provide a wavelength on tape of 1.5 mils or longer. For use of alignment tapes with other than the above frequencies, wavelength may be calculated by the formula:**

$$\lambda = \frac{v}{f}$$

**Where:**

**$\lambda$ = wavelength on tape (inches)**

**v = tape speed (in/s)**

**f = frequency (Hz)**

8. Minimize means phase error by repeating step 7 but playing back the highest frequency test tone on the alignment tape.

9. For a 4-track head assembly system, play back full sequence of test tones and observe that no phase reversal occurs. If phase reversal occurs, repeat steps 6 through 8. (Note that for a 2-track head assembly system, it is not possible to incorrectly set phase if wavelength is 1.5 mil or longer.)

10. For a 4-track head assembly system only while observing a 1.5-mil wavelength, replace the channel 4 output to the oscilloscope with channel 3 and then with channel 2. The mean phase error at this wavelength should be less than ± 10°. (Note: This figure depends on the accuracy that reproduce high-frequency equalization has been set, and upon the quality and mechanical condition of the alignment tape.)

**5-42.** *Full-Track Reproduce Head Azimuth Adjustment.* Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual.

2. As a preliminary adjustment, turn reproduce head azimuth adjusting screw (Figure 5-11) so that reference hole in tapered gear is in front of the head-gap region.

3. If an input/output assembly is not being used, connect scope or ac voltmeter to output of recorder system.

4. Select the lower of the two operating speeds selected for recorder operation.

5. Thread the appropriate full-track alignment tape (Table 5-1) on transport, and place system in thread mode.

6. While reproducing the highest tone on the alignment tape (shortest wavelength), adjust the reproduce head azimuth adjusting screw for maximum signal amplitude as read on input/output assembly meter, or on scope or ac voltmeter. (Note: At the slower tape speeds, it may be possible to set azimuth to an incorrect secondary peak. Rotate azimuth adjusting screw through 360° to ensure that the maximum amplitude peak is obtained. Continuous rotation of azimuth adjusting screw provides only ± 15 minute of arc change.)

**5-43. Operating Level Adjustment.** Operating level is set by reproducing a standard alignment tape of known short circuit fluxivity, and adjusting the recorder/reproducer reproduce gain for the desired operating level. Prior to performing the alignment procedure, refer to the general discussion concerning operating level, paragraph 5-34. Note that on Ampex alignment tapes for 15 and 30 in/s, the 185 nWb/m, 700 Hz reference tone is the first tone on the tape. For 3.75 and 7.5 in/s, the 185 nWb/m, 700 Hz (500 Hz at 3.75 in/s) tone is the last tone on the tape.

NOTE

**Where input and output line levels pertaining to the input/output assembly are stated, it is assumed that the input/output assembly has been set to the factory adjusted input and output line level of +4 dBm operating level (0 vu). If another value line input and output operating level is being used, the levels stated in the adjustment procedures should be amended by the amount of deviation from the +4 dBm operating level.**

CAUTION

**IF THE TAPE IN USE OR LOCAL STANDARDS REQUIRE THE USE OF OPERATING FLUXIVITIES LESS THAN 185 nWb/m, OR IF A HIGHER INTERFACE OUTPUT LEVEL IS DESIRED (GREATER THAN –5 dBm OUTPUT LEVEL), NOTE THAT THE REPRO GAIN ON THE PADNET MUST NOT BE INCREASED ABOVE A SENSITIVITY EQUIVALENT TO –5-dBm OUTPUT FROM THE BASIC RECORDER/REPRODUCER WHEN REPRODUCING A 185-nWb/m, 700-Hz (500-Hz AT 3.75 in/s) TONE. IF THIS PRECAUTION IS NOT OBSERVED AND A HIGH OUTPUT TAPE, SUCH AS AMPEX 456 TAPE, IS REPRODUCED ON THE ATR-100, ELECTRONIC CLIPPING MAY OCCUR BEFORE TAPE SATURATION. (THE MID-BAND SATURATED OUTPUT OF AMPEX 456 TAPE IS APPROXIMATELY +20.5 dB ABOVE 185 nWb/m.)**

NOTE

**Paragraphs 5-44 through 5-46 describe adjusting the operating level with a 2-speed PADNET installed.**

**Paragraphs 5-47 through 5-49 describe adjusting the operating level with a 4-speed PADNET installed.**

**5-44.** *370 nWb/m Operating Level Adjustment.* Use Ampex 456 tape (or direct equivalent) and proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance,* paragraphs 5-4 and 5-7.

2. Select system tape speed at the transport control panel.

3. Connect voltmeter to one of the following output connectors:

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

   b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).

4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

5. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.

6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows:

   a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R-1 on PADNET for –11 dBm at the output of the recorder/reproducer, or –2 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the –11 dBm or –2 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: –11 dBm + (+1.14 dBm) = –9.86 dBm.)

7. Repeat steps 2 through 6 for audio channels to be adjusted.

**5-45.** *260 nWb/m Operating Level Adjustment.* Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual.

2. Select system tape speed at the transport control panel.

3. Connect ac voltmeter to one of the following output connectors:

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate

recorder/reproducer output connector J13 or J14 (Figure 2-13).

b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figure 2-14).

4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

5. Thread appropriate alignment tape (Table 5-1 ) on transport and place system in thread mode.

6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows.

   a. If alignment tape track format matches the head track format, adjust REPRO GAIN control on PADNET for -8 dBm at the output of the recorder/reproducer, or +1 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the -8 dBm or +1-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -8 dBm + (+1.14 dBm) = -6.86 dBm.)

7. Repeat steps 2 through 6 for other audio channels to be adjusted.

**5-46.** *185 nWb/m Operating Level Adjustment.* Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance,* paragraphs 5-4 and 5-7.

2. Select system tape speed at the transport control panel.

3. Connect ac voltmeter to one of the following output connectors.

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

   b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).

4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

5. Thread appropriate alignment tape (Table 5-1) on transport and place system in thread mode.

6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows:

   a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R-1 on PADNET for -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add to the appropriate correction factor given in Table 5-4 to the -5-dBm or +4-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -5 dBm + (+1.14 dBm) = -3.86 dBm.)

7. Repeat steps 2 through 6 for other audio channels to be adjusted.

NOTE

**Paragraphs 5-47 through 5-49 describe adjusting the operating level with a 4-speed PADNET installed.**

**Paragraphs 5-44 through 5-46 describe adjusting the operating level with a 2-speed PADNET installed.**

**5-47.** *370 nWb/m Operating Level Adjustment.* Use Ampex 456 tape (or direct equivalent) and proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance,* paragraphs 5-4 and 5-7.

2. On PWA 5 set the I/II switch to the I position and on the transport select the higher speed of the two selected as pair I.

3. Connect voltmeter to one of the following output connectors:

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

   b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).

4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

5. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.

6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows:

   a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R26 on PADNET for −11 dBm at the output of the recorder/reproducer, or −2 dBm at the output of the input/output assembly.

   b. If using a full width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the −11 dBm or −2 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: −11 dBm + (+1.14 dBm) = -9.86 dBm.)

7. Select SYNC mode and adjust SYNC BAL for same level obtained in step 6a.

8. On PWA 5 set the I/II switch to the II position and on the transport select the higher speed of the two selected as pair II.

9. Adjust REPRO GAIN as follows:

   a. Set REPRO GAIN control R24 on PADNET for −11 dBm at the output of the recorder/reproducer, or −2 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 9a, but algebraically add the appropriate corrector factor given in Table 5-4 to the −11 dBm or −2 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: −11 dBm + (+1.14 dBm) = -9.86 dBm.)

10. On PWA 5 set the I/II switch to the I position and on the transport select the lower speed of the two selected as pair I.

11. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.

12. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows:

    a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R-25 on PADNET for −11 dBm at the output of the recorder/reproducer, or −2 dBm at the output of input/output assembly.

    b. If using a full width alignment tape on a 2- 4-track system, follow directions in step 12a but algebraically add the appropriate correction factor given in Table 5-4 to the −11 dBm or −2 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: −11 dBm + (+1.14 dBm) = -9.86 dBm.)

13. On PWA 5 set the I/II switch to the II position and on the transport select the higher speed of the two selected as pair II.

14. Adjust REPRO GAIN as follows:

    a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R-23 on PADNET for −11 dBm at the output of the recorder/reproducer, or −2 dBm at the output of the input/output assembly.

    b. If using a full width alignment tape on a 2- or 4-track system, follow directions in step 14a but algebraically add the appropriate correction factor given in Table 5-4 to the −11 dBm or −2 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: −11 dBm + (+1.14 dBm) = −9.86 dBm.)

15. Repeat steps 2 through 14 for other audio channels to be adjusted.

5-48. *260 nWb/m Operating Level Adjustment.* Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance,* paragraphs 5-4 and 5-7.

2. On PWA 5 set the I/II switch to the I position and on the transport select the higher speed of the two selected as pair I.

3. Connect voltmeter to one of the following output connectors:

    a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13).

    b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figure 2-14).

4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.

5. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.

6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows:

    a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R26 on PADNET for −8 dBm at the output of the recorder/reproducer, or +1 dBm at the output of the input/output assembly.

    b. If using a full width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the −8 dBm or +1 dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: −8 dBm + (+1.14 dBm) = −6.86 dBm.)

7. Select SYNC mode and adjust SYNC BAL for same level obtained in step 6a.

8. On PWA 5 set the I/II switch to the II position and on the transport select the higher speed of the two selected as pair II.

9. Adjust REPRO GAIN as follows:

    a. Set REPRO GAIN control R-24 on PADNET for −8 dBm at the output of the recorder/reproducer, or +1 dBm at the output of the input/output assembly.

    b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 9a but algebraically add the appropriate correction factor given in Table 5-4 to the −8-dBm or +1-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: −8 dBm + (+1.14 dBm) = −6.86 dBm.)

10. On PWA 5 set the I/II switch to the I position and on the transport select the lower speed of the two selected as pair I.

11. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.

5-49. *185 nWb/m Operating Level Adjustment.* Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described under *Preventive Maintenance*, paragraphs 5-4 and 5-7.
2. On PWA 5 set the I/II switch to the I position and on the transport select the higher speed of the two selected as pair I.
3. Connect voltmeter to one of the following output connectors:

   a. If an input/output assembly is not being used, connect ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

   b. If an input/output assembly is being used, connect ac voltmeter to appropriate output connector (Figures 2-14 and 2-15).
4. If an input/output assembly is being used, place REPRODUCE MANUAL/PRESET switch on input/output module to PRESET position.
5. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.
6. While reproducing the 700-Hz (500-Hz at 3.75 in/s), 185-nWb/m tone, adjust REPRO GAIN control as follows:

   a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R26 on PADNET for –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 6a but algebraically add the appropriate correction factor given in Table 5-4 to the –5 dBm or +4-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: –5 dBm + (+1.14 dBm) = –3.86 dBm.)
7. Select SYNC mode and adjust SYNC BAL for same level obtained in step 6a.
8. On PWA 5 set the I/II switch to the II position and on the transport select the higher speed of the two selected as pair II.
9. Adjust REPRO GAIN control as follows:

   a. Set REPRO GAIN control R24 on PADNET for –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 9a but algebraically add the appropriate correction factor given in Table 5-4 to the –5 dBm or +4-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: –5 dBm + (+1.14 dBm) = –3.86 dBm.)
10. On PWA 5 set the I/II switch to the I position and on the transport select the lower speed of the two selected as pair I.
11. Thread appropriate alignment tape (Table 5-1) on transport and place system into thread mode.
12. While reproducing the 700-Hz (500 Hz at 3.75 in/s), 185 nWb/m tone, adjust REPRO GAIN control as follows:

   a. If alignment tape track format matches the head track format, adjust REPRO GAIN control R25 on PADNET for –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

   b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 12a but algebraically add the appropriate correction factor given in Table 5-4 to the

-5 dBm or +4-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -5 dBm + (+1.14 dBm) = -3.86 dBm.)

13. On PWA 5 set the I/II switch to the II position and on the transport select the higher speed of the two selected as pair II.

14. Adjust REPRO GAIN as follows:

    a. Set REPRO GAIN control R23 on PADNET for -5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

    b. If using a full-width alignment tape on a 2- or 4-track system, follow directions in step 14a but algebraically add the appropriate correction factor given in Table 5-4 to the -5 dBm or +4-dBm level for the tape speed, track format, and reference frequency in use. (For example: at 15 in/s, 2-track system, at 700 Hz: -5 dBm + (+1.14 dBm) = -3.86 dBm.) Repeat steps 2 through 14 for other audio channels to be adjusted.

**5-50. Record Alignment.** The record alignment procedure should only be performed after reproduce equalization, reproduce gain, and reproduce head azimuth have been set or are known to be correct. Record alignment consists of setting bias level, setting record high frequency equalization, and setting system output level. The alignment procedures include instructions for aligning the record system for the first speed followed by the second speed record alignment procedure. The second speed record alignment procedure is abbreviated, as it does not require the readjustment of BIAS NORM or record head azimuth.

The following general information and conditions are applicable to both record alignment procedures.

1. Operating level is 370 nWb/m when using Ampex 456 tape or direct equivalent.
2. Operating level is 260 nWb/m when using Ampex 406 tape or equivalent.
3. Frequency response alignment is performed at the following operating levels: 15 and 30 in/s at operating level, 7.5 in/s at 10 dB below operating level, and 3.75 in/s at 20 dB below operating level.
4. Master bias operation has been set for either two-speed dual master bias operation or for four-speed master bias operation as desired. See *Changing Operating Speed Pair and Master Bias Operation* text, paragraph 5-15. (Recorder/reproducers shipped from the factory are set for four-speed master bias operation.) If two-speed dual master bias operation is selected, perform the entire record alignment procedure with bias switch S1 (Figure 5-4) in position I or II. The other position may be used to provide a preadjusted bias position for another type of tape.
5. If an input/output assembly is connected to the recorder/reproducer, the assembly is assumed to be correctly calibrated and set for +4-dBm line input and output operating level and at -5 dBm recorder/reproducer interface operating level (see *Input/Output Assembly Adjustment* procedure, paragraph 5-57).

**5-51.** *First Speed Record Alignment.* Perform the following alignment procedure for each channel (as applicable).

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.

NOTE

**For ATR-100's that utilize a 4-speed PADNET proceed to step 3.**

2. Set preset record equalization standard selector switch S1 (Figure 5-14) on PADNET to equalization standard desired for each of the two operating speeds, as shown in Table 5-10. Note that switches S1 through S1-3 are for the higher speed, and switches S1-4 through S1-6 are for the lower speed.
3. If not already set, set speed select jumpers (switches on four-speed PADNET) on PADNET

PWA for the two desired operating speeds, and set master bias operation jumpers on Audio Control PWA No. 5 for either two-speed or four-speed master bias operation. (See *Changing Operating Speed Pair and Master Bias Operation* text, paragraph 5-15.)

4. Select first tape speed to be aligned at the transport control panel.

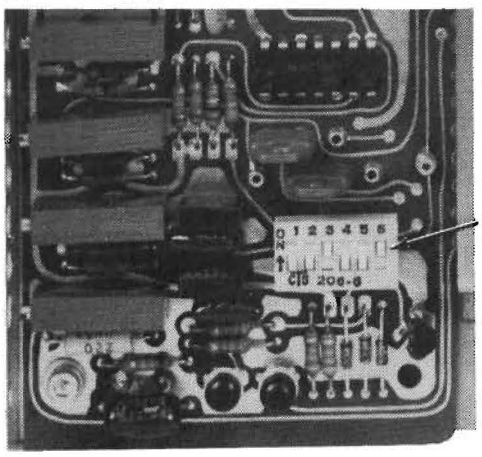



**Figure 5-14. Record Equalization Standard Selector Switch S1, 2-Speed PADNET PWA**

5. If an input/output assembly is being used, connect an ac voltmeter to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15). Set MANUAL/PRESET switch to PRESET.

6. If an input/output assembly is not being used, connect an ac voltmeter to appropriate recorder/reproducer output connector J13 or J14, and connect audio oscillator to appropriate input connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

7. Set oscillator frequency to 1.0 kHz.

8. If erase alignment has not been performed or is not known to be correct, set master erase bus level control R34 (Figure 5-15), on Audio Control PWA No. 5, to midrange position.

9. Connect scope probe to one of the following locations to monitor the amplitude of the master bias signal.

   a. If test point TP1 is present on Audio Control PWA No. 5 (later versions of the PWA), place PWA on extender board and reinstall into electronics assembly. Connect probe to TP1.

   b. If TP1 (step 9a) is not present (early versions of the PWA), place a Main Audio

**Table 5-10. Record Equalization Standard Selector Switch S1 Switch Positions (2-Speed PADNET PWA)**

| EQUALIZATION STANDARD/μs | IN/S | SWITCH S1-1 OR S1-4 | SWITCH S1-2 OR S1-5 | SWITCH S1-3 OR S1-6 (∞ OR 3180 μs) |
|---|---|---|---|---|
| AES 17.5/∞ | 30 | OFF | OFF | ON |
| NAB 50/3180 | 15 | ON | OFF | OFF |
| NAB 50/3180 | 7.5 | OFF | ON | OFF |
| IEC 35/∞ | 15 | OFF | OFF | ON |
| IEC 70/∞ | 7.5 | OFF | OFF | ON |
| NAB/IEC 90/3180 | 3.75 | OFF | ON | OFF |
| NOTE: Switches S1-1 through S1-3 are for the higher of the two speeds. Switches S1-4 through S1-6 are for the lower of the two speeds. | | | | |

PWA and PADNET on extender board and reinstall into electronics assembly. Connect probe to pin FF on PADNET.

10. Apply power, and adjust appropriate MASTER BIAS level control (Table 5-11 or Table 5-12) for the speed in use to provide a 2.5-Vp-p, 432-kHz square wave on scope.

11. Remove power and scope probe from PWA (step 9). Reinstall PWA into electronics assembly.

12. Apply system power, thread a reel of bulk-erased tape on transport, and place system into thread mode.

13. Select input monitoring for channel being aligned.

14. Adjust audio oscillator output to provide −5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

15. Place channel(s) being aligned in ready mode.

16. Place system in record mode.

17. Select repro monitoring for channel being aligned.

18. Adjust BIAS NORM control (Table 5-7) on PADNET for maximum 1.0-kHz output.

19. Adjust REC GAIN control (Table 5-7) on 2-speed PADNET (or appropriate RECORD GAIN on 4-speed PADNET [Table 5-8]) for −5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

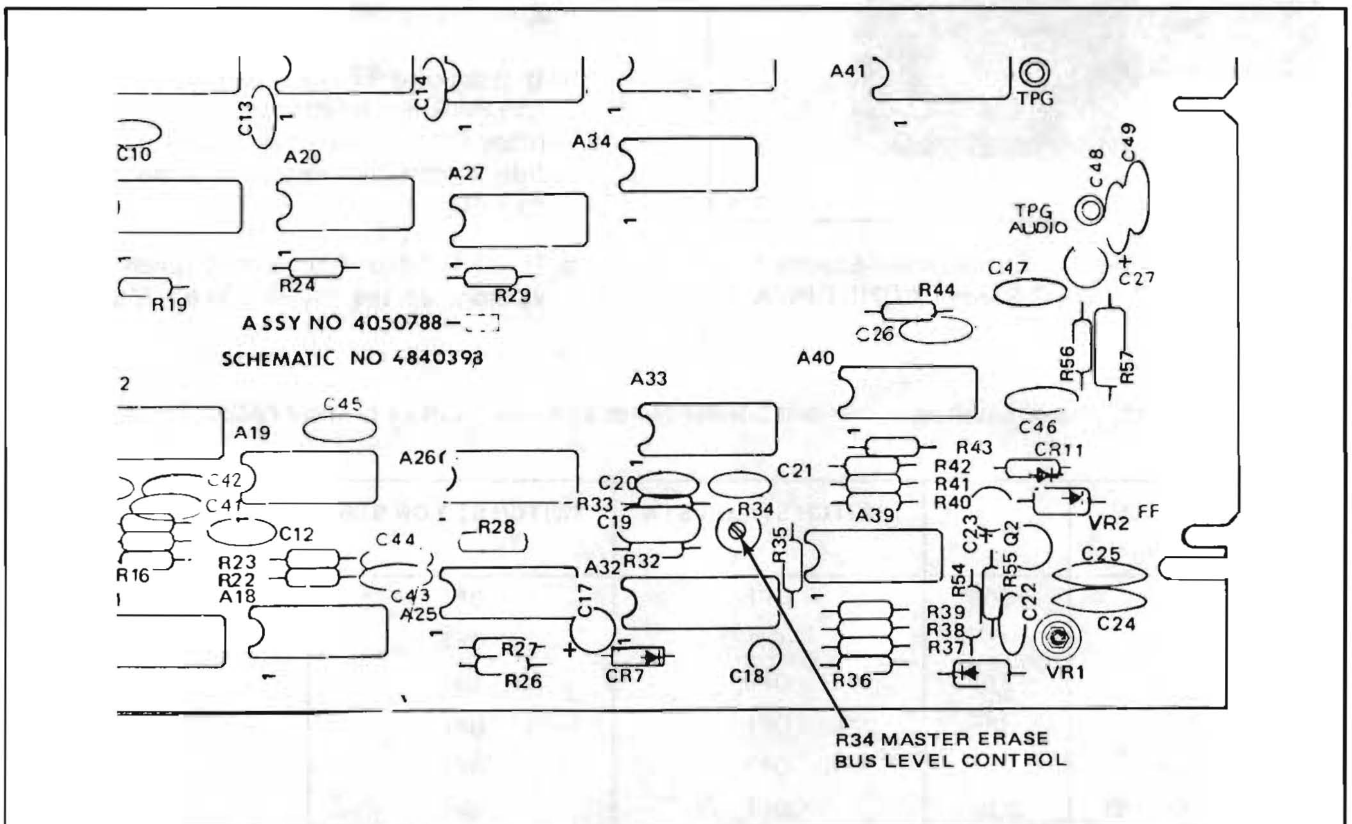
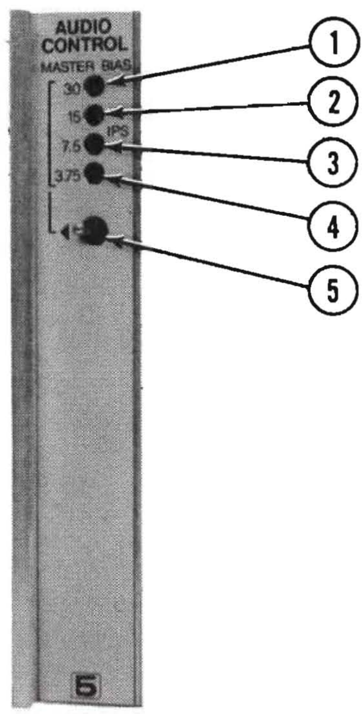



Figure 5-15. Audio Control PWA No. 5

Table 5-11. Audio Control PWA No. 5 — 4-Speed Alignment Controls

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| INDEX NO. | CONTROL | FUNCTION |
|---|---|---|
| 1 | 30 (R6) | Adjusts 30-in/s master bias level. |
| 2 | 15 (R5) | Adjusts 15-in/s master bias level. |
| 3 | 7.5 (R4) | Adjusts 7.5-in/s master bias level. |
| 4 | 3.75 (R3) | Adjusts 3.75-in/s master bias level. |
| 5 | Switch (S1) | (Switch to remain in left-hand position for four-speed operation.) |

20. Set audio oscillator to 25 kHz at 30 in/s, 15 kHz at 15 in/s or 7.5 in/s, or 7.5 kHz at 3.75 in/s.

21. Adjust record head azimuth adjustment screw (Figure 5-11) for maximum signal output.

22. Adjust bias by overbiasing a short wavelength signal (1.5 mils) for the speed in use as follows.

    a. Set oscillator to frequency given in Table 5-13 for speed in use.

    b. Reduce oscillator output level to obtain signal output level given in Table 5-13 for speed in use. (The output level is relative to the level set in step 19.

    c. Adjust BIAS NORM control (Table 5-7) on PADNET counterclockwise until level of signal being reproduced starts to fall. Then turn BIAS NORM slowly clockwise for maximum signal output. (If necessary, reduce oscillator level to maintain level set in step 22b.)

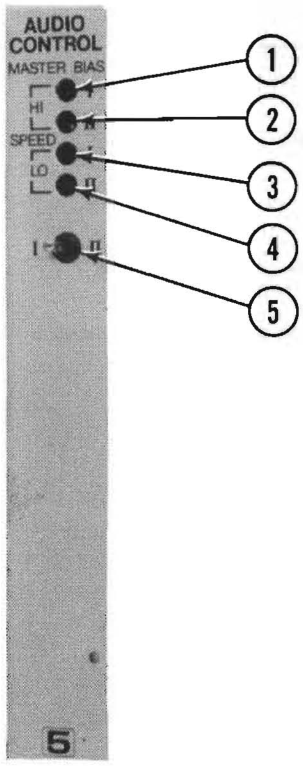
    d. Continue turning BIAS NORM control clockwise until level has dropped from the maximum level obtained in step 22c by the amount specified in Table 5-13 for the speed and tape use.

23. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).

24. Adjust audio oscillator output level to provide the following system output level:

    a. If input/output assembly is not being used, adjust oscillator output for −5 dBm at 15

**Table 5-12. Audio Control PWA No. 5 – Two-Speed Alignment Controls**



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| INDEX NO. | CONTROL | FUNCTION |
|---|---|---|
| 1 | HI I (R6) | Adjusts high-speed I master bias level. |
| 2 | HI II (R5) | Adjusts high-speed II master bias level. |
| 3 | LO I (R4) | Adjusts low-speed I master bias level. |
| 4 | LO II (R3) | Adjusts low-speed II master bias level. |
| 5 | I/II Switch (S1) | Selects master bias I or II. |

**Table 5-13. Recommended Frequency, Signal Level, and Overbias Values for Bias and Equalization Adjustment**

| SPEED | FREQUENCY | LEVEL FOR BIAS AND EQUALIZATION ADJUSTMENT (Relative to 1.0 kHz Operating Level*) | OVERBIAS VALUE | |
|---|---|---|---|---|
| | | | 406/407 TAPE | 456 TAPE |
| 30 in/s | 20 kHz | 0 | 1.75 ±0.25 dB | 2.75 ±0.25 dB |
| 15 in/s | 10 kHz | 0 | 1.75 ±0.25 dB | 2.75 ±0.25 dB |
| 7.5 in/s | 5 kHz | −10 dB | 1.75 ±0.25 dB | 2.75 ±0.25 dB |
| 3.75 in/s | 2.5 kHz | −20 dB | 1.75 ±0.25 dB | 2.75 ±0.25 dB |

*Recommended operating level is 370 nWb/m using Ampex 456 tape or 260 nWb/m using Ampex 406/407 tape.

NOTE: Frequency at each tape speed shown in the table has been chosen to provide a short wavelength signal of 1.5 mils.

and 30 in/s, −15 dBm at 7.5 in/s, or −25 dBm at 3.75 in/s.

b. If input/output assembly is being used, adjust oscillator output for +4 dBm at 15 and 30 in/s, −6 dBm at 7.5 in/s, or −16 dBm at 3.75 in/s.

25. Set oscillator frequency to 20 kHz at 30 in/s, 15 kHz at 15 in/s, 10 kHz at 7.5 in/s, or 7.5 kHz at 3.75 in/s.

26. Adjust appropriate record equalizer control (HI SPEED or LO SPEED) on 2-speed PADNET (Table 5-7) or (EQ) on 4-speed PADNET (Table 5-8) for same level as in step 24.

27. Sweep oscillator through the following frequency range and fine-adjust the appropriate reproduce equalizer control (HI SPEED LF or LO SPEED LF) on 2-speed PADNET (Table 5-7) or REPRO HF EQ or REPRO LF EQ (Table 5-9) on 4-speed PADNET to obtain the most uniform low frequency response.

    a. 30 in/s – 35 Hz to 400 Hz

    b. 15 in/s, 7.5 in/s, or 3.75 in/s – 20 Hz to 200 Hz

28. Sweep oscillator through frequency ranges given in Table 5-14 for speed in use. Output should remain within limits shown in Table 5-14 for each frequency range. If necessary, make slight adjustments to the appropriate record high-frequency equalizer control (HI SPEED or LO SPEED) and/or reproduce low-frequency equalizer control (HI SPEED LF or LO SPEED LF) on 2-speed PADNET PWA (Table 5-7) to obtain flattest midband response consistent with meeting extreme high- and low-frequency tolerances.

    a. When adjusting the 4-speed PADNET use appropriate record equalizer control (EQ) and/or appropriate reproduce low frequency control (REPRO LF EQ) Table 5-9.

    b. Midband response may be further flattened by using the appropriate shelfing control on the 4-speed PADNET.

29. Select input monitoring for channel being aligned.

30. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).

31. Adjust oscillator output level for –5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.

32. Select repro monitoring for channel being aligned.

33. Adjust REC GAIN on 2-speed PADNET PWA (Table 5-7) or appropriate RECORD GAIN on 4-speed PADNET (Table 5-8) for –5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.

34. For a single-channel system, this completes the record alignment for the first speed selected for adjustment. To adjust for the second speed, proceed to the *Second Speed Record Alignment* procedure, paragraph 5-52.

**Table 5-14. Overall Record/Reproduce Frequency Response**

| SPEED/EQUALIZATION STANDARD | REFERENCE FREQUENCY | TOLERANCE ±0.75 dB | TOLERANCE ±2.0 dB | LEVEL FOR FREQUENCY RESPONSE RELATIVE TO OPERATING LEVEL* |
|---|---|---|---|---|
| 30 in/s AES | 1 kHz | 200 Hz – 20 kHz | 35 Hz – 25 kHz | 0 dB |
| 15 in/s NAB or IEC | 1 kHz | 100 Hz – 15 kHz | 20 Hz – 20 kHz | 0 dB |
| 7.5 in/s NAB or IEC | 500 Hz | 100 Hz – 10 kHz | 30 Hz – 15 kHz | –10 dB |
| 3.75 in/s NAB/IEC | 500 Hz | (not specified) | 30 Hz – 10 kHz** | –20 dB |

*Operating level is 370 nWb/m at 700 Hz for Ampex 456 tape and 260 nWb/m at 700 Hz for Ampex 406/407 tape.
**For Ampex 456 tape.
For Ampex 406/407 tape specification is: 30 Hz – 7.5 kHz, ±2.0 dB.

35. For a 2-track or 4-track system, align the other channels for the same speed in use by following the *First Speed Record Alignment* procedure, steps 2, 5, 6, 14 through 20, and 22 through 33. Do not readjust MASTER BIAS level control on Audio Control PWA No. 5 (steps 9 and 10) and do not readjust record head azimuth (steps 20 and 21).

5-52. *Second Speed Record Alignment.* When aligning the record system for a second speed after all channels have been adjusted for the first speed, none of the BIAS NORM controls are readjusted. Bias level for the second speed is set by adjusting the appropriate MASTER BIAS level control on Audio Control PWA No. 5. When aligning a 2-track or 4-track system, the MASTER BIAS level need only be set once while monitoring the output of any one channel. The bias level for the other channel(s) is automatically set correctly to the same biasing point as the channel that was monitored.

To align the record system for a second speed after the first speed has been adjusted, proceed as follows:

1. Set system tape speed at the transport control panel.
2. Set oscillator frequency to 1.0 kHz.
3. Select input monitoring for channel being aligned.
4. Adjust audio oscillator output to provide –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.
5. Place channel being aligned in ready mode.
6. Place system in record mode.
7. Select repro monitoring for channel being aligned.
8. Adjust bias by overbiasing a short wavelength signal (1.5 mils) for the speed in use as follows:
   a. Set oscillator to frequency given in Table 5-13 for speed in use.
   b. Reduce oscillator output level to obtain signal output level given in Table 5-13 for speed in use.
   c. Adjust appropriate MASTER BIAS control (Table 5-11 or 5-12), on audio control PWA 5, counterclockwise until level of signal being reproduced starts to fall. Then turn MASTER BIAS control slowly clockwise for maximum signal output. (If necessary, reduce oscillator level to maintain level set in step 8b.)
   d. Continue turning MASTER BIAS control clockwise until level has dropped from the maximum level obtained in step 8c by the amount specified in Table 5-13 for the speed and tape in use.
9. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).
10. Adjust audio oscillator output level to provide the following system output level:
    a. If input/output assembly is not being used, adjust oscillator output for –5 dBm at 15 and 30 in/s, –15 dBm at 7.5 in/s, or –25 dBm at 3.75 in/s.
    b. If input/output assembly is being used, adjust oscillator output for +4 dBm at 15 and 30 in/s, –6 dBm at 7.5 in/s, or –16 dBm at 3.75 in/s.
11. Set oscillator frequency to 20 kHz at 30 in/s, 15 kHz at 15 in/s, 10 kHz at 7.5 in/s, or 7.5 kHz at 3.75 in/s.
12. Adjust appropriate record equalizer control (HI SPEED or LO SPEED) on 2-speed PADNET (Table 5-7) or (EQ) on 4-speed PADNET (Table 5-8) for same level as in step 10.
13. Sweep oscillator through the following frequency range and fine-adjust the appropriate reproduce equalizer control (HI SPEED LF or LO SPEED LF) on 2-speed PADNET

(Table 5-7) or (REPRO LF EQ) on 4-speed PADNET (Table 5-9) to obtain the most uniform low-frequency response.

a. 30 in/s — 35 Hz to 400 Hz.

b. 15 in/s, 7.5 in/s, or 3.75 in/s — 20 Hz to 200 Hz.

14. Sweep oscillator through frequency ranges given in Table 5-14 for speed in use. Output should remain within limits shown in Table 5-14 for each frequency range. If necessary, make slight adjustments to the appropriate record high-frequency equalizer control (HI SPEED or LO SPEED) and/or reproduce low-frequency equalizer control (HI SPEED LF or LO SPEED LF) on PADNET PWA (Table 5-7) to obtain flattest midband response consistent with meeting extreme high- and low-frequency tolerances.

    a. When adjusting the 4-speed PADNET use appropriate record equalizer control (EQ) and/or appropriate reproduce low frequency equalizer control (REPRO LF EQ) (Table 5-9).

    b. Midband response may be further flattened by using the appropriate shelving control on the 4-speed PADNET.

15. Select input monitoring for channel being aligned.

16. Set oscillator frequency to 1.0 kHz (500 Hz at 3.75 in/s).

17. Adjust oscillator output level for −5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.

18. Select repro monitoring for channel being used.

19. Check that reproduced level is −5 dBm ±0.5 dB at the output of the recorder/reproducer, or is +4 dBm ±0.5 dB at the output of the input/output assembly.

**5-53.** *2-Track or 4-Track Record Head Azimuth and Phase Adjustment.* The adjustment of record head azimuth and phase (multitrack systems only) should not be attempted unless the following criteria have been met: reproduce equalization is correct, reproduce head azimuth has been set using a standard alignment tape, and record equalization and bias are known to be correct. Prior to performing the alignment procedure, refer to the general discussion concerning head azimuth and phase adjustment, paragraph 5-33. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* section of the manual, paragraphs 5-4 and 5-7.

2. As a preliminary adjustment, turn record head azimuth adjusting screw (Figure 5-12) so that reference hole in tapered gear is in front of the head-gap region.

3. Connect a dual trace scope as follows:

    NOTE

    **If a dual trace scope is not available, proceed to step 4.**

    a. For a 2-track head assembly system, connect scope to channel 1 and to channel 2 outputs of the recorder system.

    b. For a 4-track head assembly system, connect scope to channel 1 output and to channel 4 output of the recorder system.

    c. Trigger scope from recorder channel 1 output.

    d. Proceed to step 5.

4. If a dual trace scope is not available, connect a single-channel scope to display a Lissajou pattern as follows:

    a. For a 2-track head assembly system, connect channel 1 output to the vertical input of scope and connect channel 2 output to the horizontal input of the scope.

b. For a 4-track head assembly system, connect channel 1 output to the vertical input of scope and connect channel 4 output to the horizontal input of the scope.

5. Connect audio oscillator to input of recorder system to drive all channels simultaneously.

6. Set oscillator frequency to 1.0 kHz.

7. Connect ac voltmeter to any one of the audio outputs.

8. Apply power and thread a reel of tape on transport and place system into thread mode.

9. Select the lower of the two operating speeds.

10. Place all channels into record mode.

11. Select repro monitoring mode.

12. Adjust oscillator output level for –5 dBm at the output of the recorder/reproducer or for +4 dBm at the output of the input/output assembly.

13. Adjust record head azimuth adjusting screw (Figure 5-12) for minimum phase error (or straight 45° line on Lissajou display).

14. Increase oscillator frequency to frequency specified in Table 5-13 for speed in use.

15. Reduce oscillator output level as required to provide system output level specified in Table 5-13 relative to level set in step 12 at 1.0 kHz.

16. Fine-adjust record head azimuth adjusting screw to further minimize mean phase error.

17. If system is a 4-track head assembly system, replace channel 4 input to oscilloscope with channel 3 and repeat step 15. Repeat this step and step 15, but with scope connected to channel 2. The maximum mean phase error difference from channel 1 to channel 4 should not exceed ± 10° at frequencies shown in frequency column of Table 5-13.

NOTE

**Dynamic phase errors are mainly dependent upon tape slitting accuracy and other tape related factors. Typical dynamic phase errors are as follows:**

**2-track — 1/4-inch tape systems, ± 15° at 1.5 mil wavelength recorded on tape.**
**4-track — 1/2-inch tape systems, ±25° at 1.5 mil wavelength recorded on tape.**

**(A 1.5-mil wavelength recorded on tape is equivalent to 20 kHz at 30 in/s, 10 kHz at 15 in/s, 5 kHz at 7.5 in/s, or 2.5 kHz at 3.75 in/s.)**

**5-54.** *Full-Track Record Head Azimuth Adjustment.* The adjustment of record head azimuth should not be attempted unless the reproduce head azimuth has been set using a standard alignment tape. Prior to performing the alignment procedure, refer to the general discussion concerning head azimuth adjustment, paragraph 5-33. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* section of the manual, paragraphs 5-4 and 5-7.

2. As a preliminary adjustment, turn record head azimuth adjusting screw (Figure 5-12) so that reference hole in tapered gear is in front of the head-gap region.

3. Connect a scope or ac voltmeter to the output of the recorder system.

4. Connect an audio oscillator to input of recorder system.

5. Apply power and thread a reel of tape on transport and place system into thread mode.

6. Select the lower of the two operating speeds.

7. Place recorder/reproducer into record mode.

8. Select repro monitoring mode.

9. Set oscillator frequency to upper band edge frequency shown in Table 5-14 for speed in use.

10. Adjust oscillator output to level for –5 dBm at the output of the recorder/reproducer, or for +4 dBm at the output of the input/output assembly.

11. Readjust oscillator output level shown in Table 5-14 for the level of frequency response relative to operating level for the speed in use.

12. Adjust record head azimuth adjusting screw (Figure 5-12) for maximum system output level.

**5-55. Sel Sync Equalization and Gain Adjustment.** The sel sync equalization and gain adjustment is made while reproducing a recording made on the recorder/reproducer. The recorder/reproducer has an additional low-frequency reproduce equalizer for the sel-sync mode which must be adjusted prior to the adjustment of SEL SYNC gain. Since sel-sync mode is most commonly used for 15- and 30-in/s operation, adjustment instructions are given for these two speeds. The sel-sync adjustment procedure should only be performed after the reproduce and record alignment procedures have been performed. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.

2. Set sel-sync equalization control R15 on Main Audio PWA (Figure 5-13) to the center of its range.

3. Place Main Audio PWA of channel to be aligned on extender board and install into electronics assembly.

4. If an input/output assembly is being used, connect an ac voltmeter to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).

5. If an input/output assembly is not being used, connect an ac voltmeter to appropriate recorder/reproducer output connector J13 or J14, and connect audio oscillator to appropriate input connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

6. Apply power, thread reel of tape on transport, and place system into thread mode.

7. Set oscillator frequency to 1.0 kHz.

8. Select input monitoring for channel being aligned.

9. Adjust audio oscillator output to provide –5 dBm at the output of the recorder/reproducer or +4 dBm at the output of the input/output assembly.

10. Place channel being aligned in ready mode.

11. Select 15- or 30-in/s tape speed and place system into record mode.

12. Select repro monitoring for channel being aligned.

13. Verify that system output level is –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly. If output is not as specified, perform the applicable reproduce or record alignment procedure.

14. Set tape timer to zero and continue to record 1.0-kHz signal for five seconds.

15. Switch oscillator frequency to 100 Hz and note 100-Hz reproduced output level relative to 1.0-kHz output level. Continue alternating oscillator input frequency between 1.0 kHz and 100 Hz at five-second intervals for at least two minutes.

16. Stop recording and rewind tape to tape-timer zero.

17. Place channel being aligned in sync mode.

18. Place system in play mode.

19. Adjust SYNC GAIN control (Table 5-7) on 2-speed PADNET or SYNC BALANCE control (Table 5-9) on 4-speed PADNET PWA to obtain output of –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

20. Carefully adjust sel-sync equalization control R15 (Figure 5-13) during 1.0-kHz tone until 100-Hz level and 1.0-kHz level have the same value.

21. Remove system power and replace Main Audio PWA into electronics assembly without extender board.

22. Reapply system power, select sync mode for channel being aligned, and place system in play mode to reproduce recording made in step 15.

23. Note the relative difference between the 100-Hz signal and the 1.0-kHz signal as compared to relative difference noted in step 15. If relative error differs more than ±0.5 dB, remove system power and make a small adjustment to R15 on Main Audio PWA. (Note: Turning R15 clockwise increases 1.0-kHz level relative to 100-Hz level.)

24. Repeat steps 22 and 23 as necessary to reduce error to within ±0.5 dB.

25. Set tape timer to zero and record a 1.0-kHz signal for 15 seconds.

26. While still recording, record a slow sweep in frequency from 40 Hz to 12 kHz at 15 in/s, or 80 Hz to 15 kHz at 30 in/s.

27. Stop recording and rewind tape to tape-timer zero.

28. Select sync mode for channel being aligned.

29. Place system in play mode.

30. While reproducing the 1-kHz tone, adjust SYNC GAIN or SYNC BALANCE on 4-speed PADNET for –5 dBm at the output of the recorder/reproducer, or +4 dBm output of the input/output assembly.

31. While reproducing the sweep tone recorded in step 26, verify that the output is within ±2 dB of the 1-kHz level recorded in step 25.

**5-56. Erasure Depth Adjustment and Measurement.** The erase current supplied to the erase head is adjustable by means of a master erase bus potentiometer control on Audio Control PWA 5. This is the only adjustment required for the erase system. Because of the extreme erase depth of which the recorder/reproducer is capable, it is mandatory that the tape used for adjustment and depth measurement be thoroughly bulk degaussed. This will prevent any crosstalk from an unerased portion of the tape being interpreted as the erased signal level. For accurate measurement of erasure depth, a spectrum analyzer, wave analyzer, or 1/10 octave filter should be used. If these instruments are unavailable, a reasonably accurate adjustment can be made by listening to the erased signal at an elevated monitoring level. The erase performance specifications given in this procedure apply to Ampex 406, 407, or 456 tape or the exact equivalent. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-3 and 5-7.

2. Set master erase bus level control R24 on Audio Control PWA No. 5 (Figure 5-15) to the center of its range.

3. Place audio control PWA No. 5 on an extender board and install into electronics assembly.

4. If an input/output assembly is being used, connect a spectrum analyzer, wave analyzer, or 1/10 octave filter to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).

5. If an input/output assembly is not being used, connect a spectrum analyzer, wave analyzer, or 1/10 octave filter to appropriate recorder/reproducer output connector J13 or J14, and connect an audio oscillator to appropriate input connector J13 or J14 (Figures 2-13 and Tables 2-2 and 2-3).

6. Apply power, thread a reel of bulk-degaussed tape of the same kind that was used to align the reproduce and record circuits. Place system into thread mode.

7. Set speed select switch to highest operating speed.

8. Place system in record mode (channels not under test should also be placed in record mode).

9. Set oscillator frequency to appropriate frequency as follows: 400 Hz at 30 in/s, 200 Hz at 15 in/s, or 100 Hz at 7.5 in/s. Adjust oscillator output level for +5 dBm at the output of the recorder/reproducer, or +14 dBM at the output of the input/output assembly.

10. Adjust analyzer to zero reference, or note analyzer range setting and meter reading.

11. Reset tape timer display to zero.

12. Record continuously for five minutes and rewind tape to tape timer display zero.

13. Remove oscillator and short signal input terminals (or short input with an impedance not greater than 300 ohms).

14. Again place system into record mode and adjust analyzer range setting to observe residual erase signal level.

15. Adjust R34 (Figure 5-15) slowly counterclockwise, and note when erased signal amplitude suddenly increases. Then adjust R34 slowly clockwise until erase signal is 85 dB below unerased level established in step 9 (−80 dBm at the output of the recorder/reproducer or −71 dBm at the output of the input/output assembly). If a wave analyzer or spectrum analyzer with a resolution bandwidth less than 5 Hz is being used, continue turning R34 clockwise until a minimum amplitude erased signal is seen.

16. Without disturbing the setting of R34 established in step 15, repeat steps 8 through 14 for the other channel(s). If any channel does not measure at least 85 dB below the unerased level, repeat step 15 for that channel.

17. Connect oscilloscope to TP2 (144 kHz) on audio control PWA No. 5.

18. Note peak-to-peak amplitude of square wave signal. Voltage level at TP2 should not exceed 6 Vp-p. At that setting of R34, the residual erased signal level will normally be greater than 90 dB below unerased level set in step 9.

**5-57. Input/Output Assembly Adjustment.** Procedures for adjusting offset null, input and output operating level, and level meter calibration are given below. Instructions for setting the operating input and output level to +4 dBm are given, but other values may be selected by the user. Input levels can be from +30 to −5 dBm in the variable mode or +20 dBm to −1 dBm in the preset mode. Output levels can be from +12 dBm to −25 dBm in the variable mode or from +20 dBm to −1 dBm in the preset mode. (However, the interface input and output operating level to and from the ATR-100 should be set to −5 dBm regardless of the levels selected for the input/output assembly line input and line output.)

Two methods for adjusting the input and output levels are presented. Method 1 requires a jumper/clip lead and standard test equipment interconnect cables. Method 2 requires an I/O Level Set Accessory (Ampex Part No. 4020425) shown in Figure 5-16.) This accessory consists of a printed circuit board that is plugged into the ATR-100 electronics assembly (on an extender board) in place of the standard audio PWA. The accessory connects the signal input and output of the input/output assembly together and provides a coaxial cable fitted with a GR plug that connects to an ac voltmeter. Each method will enable equal results but method 2 is more convenient for the user and, therefore, is the preferred method. Refer to Figures 5-17 and 5-18 and proceed as follows:

CAUTION

DO NOT REMOVE OR INSERT AN INPUT/OUTPUT MODULE OR ATR-100 PWA WITH POWER ON. TO DO SO MAY CAUSE DAMAGE TO COMPONENTS.

**5-58.** *Offset Null Adjustments.* Perform these steps on each input/output module only if repairs have been made or components have been changed on the input/output assembly that may affect circuit operation.

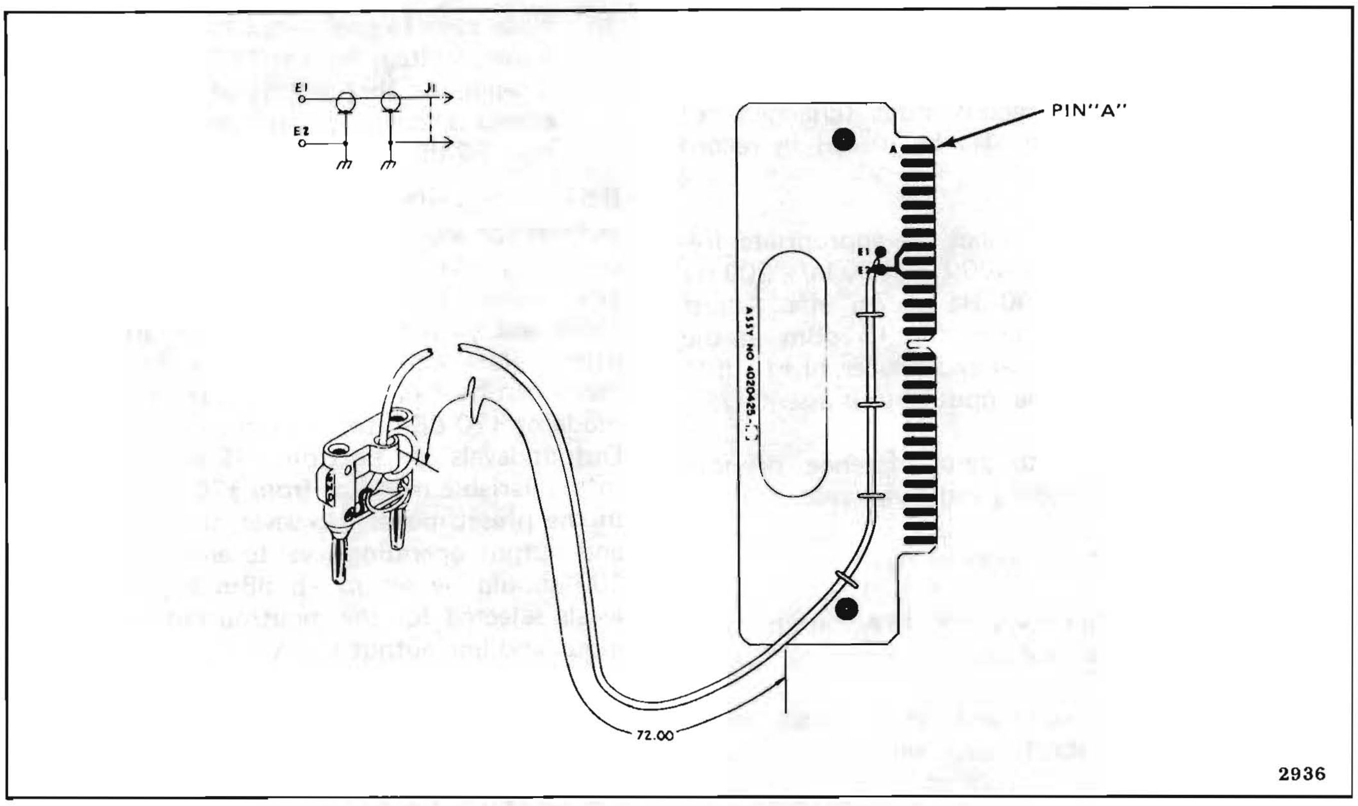



Figure 5-16. I/O Level Set Accessory

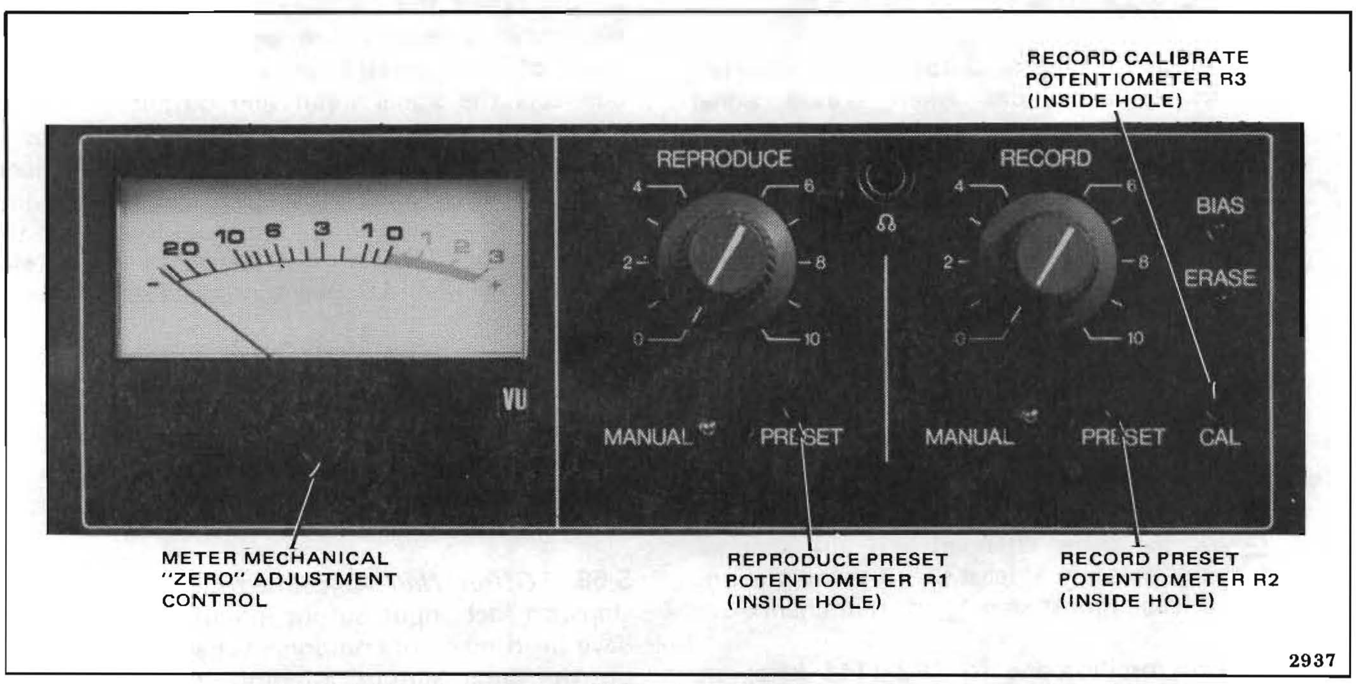



Figure 5-17. Input/Output Module Adjustment Control Locations

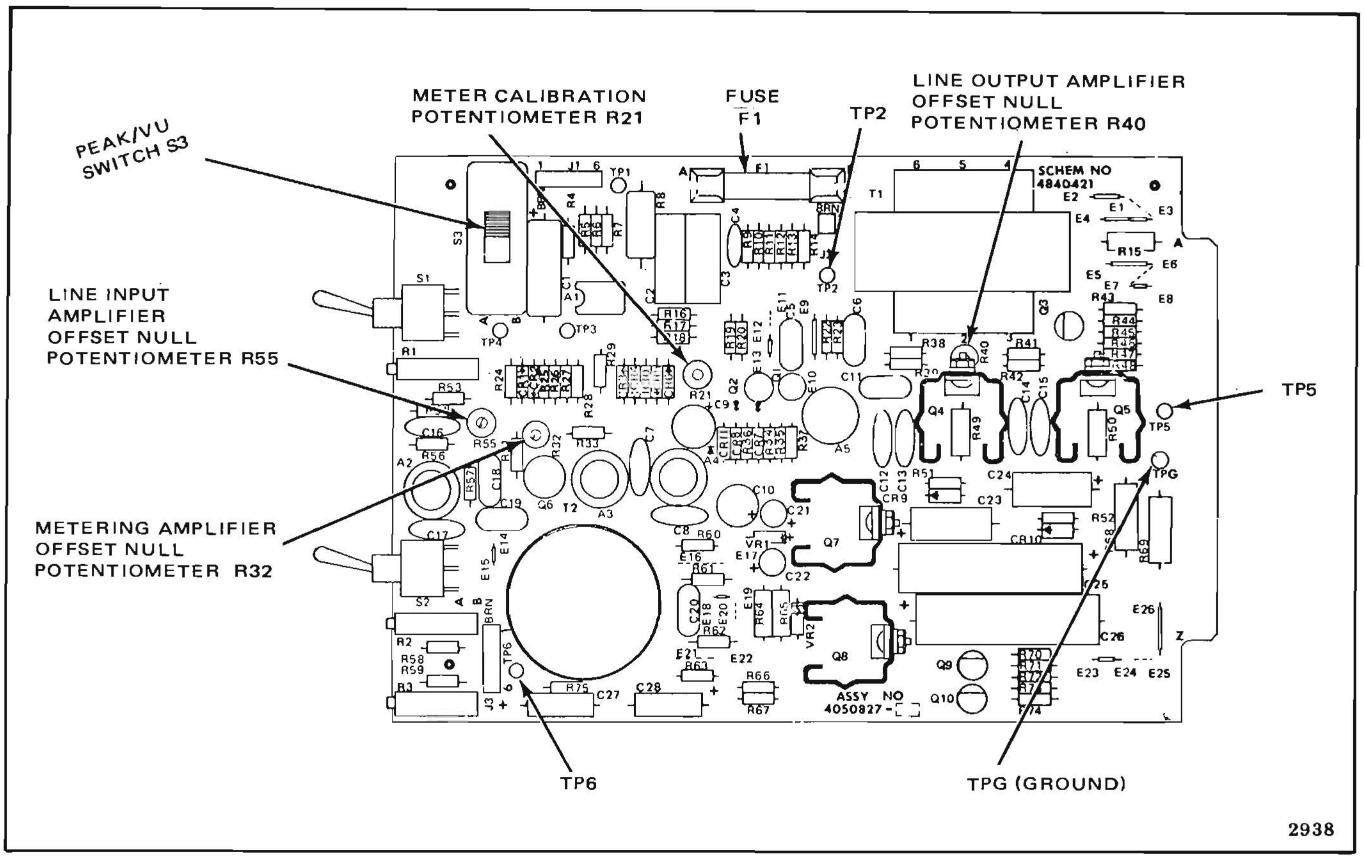



**Figure 5-18. Input/Output Module Assembly**

1. With power removed, adjust the meter mechanical "zero" adjustment control (Figure 5-17) for mechanical zero (meter at left-hand dial position).
2. Remove input/output module from input/output mainframe and place module on an extender board (Table 5-1). Insert extender board into mainframe.
3. Remove fuse F1 (Figure 5-18).
4. Set peak/vu switch S3 to desired operating position (peak or vu reading on vu/peak meter).
5. Disconnect signal input so that there is no signal being fed to input/output assembly.
6. Apply power and adjust metering amplifier offset null potentiometer R32 (Figure 5-18) for zero indication (same as step 1) on the level meter.
7. Connect a dc voltmeter to TP6 and ground (Figure 5-18).
8. Set RECORD MANUAL/PRESET switch to MANUAL position.
9. Adjust line input amplifier offset null potentiometer R55 for zero change in voltage at TP6 while rotating RECORD potentiometer through its range.
10. Connect dc voltmeter to TP2 and ground (Figure 5-18).
11. Adjust line output amplifier offset null potentiometer R40 (Figure 5-18) for 0 ±30 mV at TP2. Remove dc voltmeter.
12. Remove power and reinstall fuse F1.

**5-59.** *Record Level Adjustment (Method 1).* Proceed as follows:

1. Connect an audio oscillator to the line input connector (Figure 2-14). Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +4 dBm (or other operating level selected by the user).

2. Connect ac voltmeter to TP6 and ground (Figure 5-18).

3. Set RECORD MANUAL/PRESET switch to PRESET position.

4. Adjust record preset potentiometer R2 (Figure 5-17) for –5 dBm level at TP6.

5. Connect ac voltmeter to line output connector (Figure 2-14) and terminate line output with 600 ohms, or place switch (Figure 2-14) in the terminate position.

6. Select input monitoring for channel being aligned.

7. Adjust record calibrate potentiometer R3 (Figure 5-17) for +4-dBm level on the ac voltmeter (or other line output operating level selected by the user).

8. Remove power and set peak/vu meter switch S3 (Figure 5-18) to desired operating position, peak or vu. Reapply power.

9. Select input monitoring for channel being aligned.

10. Adjust meter calibration potentiometer R21 (Figure 5-18) for indication of –6 dB (meter switch S3 in peak position) or 0 vu (meter switch S3 in vu position).

**5-60.** *Reproduce Level Adjustment (Method 1).* Proceed as follows:

1. Remove power and remove all audio PWA's from the recorder/reproducer electronics assembly.

2. Connect a jumper from TP5 to TP6 (Figure 5-18).

3. Connect an audio oscillator to the line input connector (Figure 2-14). Set frequency to 1.0 kHz and output level to +4 dBm (or other operating level selected by the user).

4. Set REPRODUCE MANUAL/PRESET switch to PRESET position.

5. Connect ac voltmeter to line output connector (Figure 2-14) and terminate line output with 600 ohms or place switch (Figure 2-14) in the terminate position.

6. Apply power and adjust reproduce preset potentiometer R1 (Figure 5-17) for +4-dBm level on the ac voltmeter (or other line operating level selected by the user).

7. Repeat the *Record Level Adjustment (Method 1)* and *Reproduce Level Adjustment (Method 1)* procedures for the other audio channels.

8. With power off, remove input/output module and extender board from input/output mainframe. Remove jumper connected from TP5 to TP6. Reinstall input/output module into mainframe.

9. Reinstall all audio PWA's into the recorder/reproducer electronics assembly.

**5-61.** *Record and Reproduce Level Adjustment (Method 2).* Proceed as follows:

1. Remove power and remove all audio PWA's from the recorder/reproducer.

2. Install recorder/reproducer extender board into electronics assembly corresponding to channel to be adjusted.

3. Install I/O level set accessory connector (Figure 5-16) into extender board with pin A in the uppermost position. Connect cable to ac voltmeter.

4. Remove input/output module from input/output mainframe and place module on an extender board (Table 5-1). Insert extender board into mainframe.

5. Connect an audio oscillator to line input connector (Figure 2-14). Set oscillator frequency to 1.0 kHz and adjust oscillator output level to +4 dBm (or other input operating level selected by the user).

6. Set RECORD MANUAL/PRESET switch to PRESET position.

7. Apply power and adjust record preset potentiometer R2 (Figure 5-17) for −5-dBm level on the ac voltmeter connected to the I/O level set accessory.

8. Connect ac voltmeter to line output connector (Figure 2-14) and terminate line output with 600 ohms or place switch (Figure 2-14) in the terminate position.

9. Select input monitoring for channel being aligned.

10. Adjust record calibrate potentiometer R3 (Figure 5-17) for +4-dBm level on the ac voltmeter (or other line output operating level selected by the user).

11. Select repro monitoring for channel being aligned.

12. Set REPRODUCE MANUAL/PRESET switch in the PRESET position.

13. Adjust reproduce preset potentiometer R1 (Figure 5-17) for +4-dBm level on the ac voltmeter (or other line output operating level selected by the user).

14. Remove power and set peak/vu meter switch S3 (Figure 5-18) to desired operation position, peak or vu. Reapply power.

15. Adjust meter calibration potentiometer R21 (Figure 5-18) for indication of −6 dB (meter switch S3 in peak position) or 0 vu (meter switch S3 in vu position).

16. Repeat procedure for the other audio channels.

17. With power off, remove input/output module and extender board from input/output mainframe. Reinstall input/output module into mainframe.

18. Remove extender board from electronics assembly and reinstall audio PWAs removed in step 1.

**5-62. PURC Timing Alignment.** The recorder/reproducer is capable of operating with or without PURC operation on each channel, as desired, by placement of a jumper located on each two-speed PADNET or a switch on each four-speed PADNET PWA. See *Installation* section of the manual (paragraph 2-30) for jumpering information. (Note: recorder/reproducers shipped from the factory are set for normal non-PURC, operation.)

The only adjustment required for PURC alignment is the adjustment of PURC timing to normalize the delay timing to establish correct operation for all speeds. Once the adjustment control has been set for one speed, timing is automatically set when the other speed is selected.

To aid in the alignment of the PURC timing, an optional automatic record/play cycler may be used to cycle the recorder/reproducer for insert-edit operation (paragraph 3-19) while the PURC timing adjustment is being made. (The cycler is constructed by the user. See Figure 5-19 for cycler schematic diagram and parts list.) The PURC alignment procedure should only be performed if the record, reproduce, and erase alignment is known to be correct. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.

2. Connect an audio oscillator to audio input connector corresponding to first channel to be aligned.

3. Set oscillator frequency to 1.0 kHz.

4. Connect scope to audio output connector corresponding to first channel to be aligned.

5. Adjust scope time base for 1.0-second horizontal sweep.

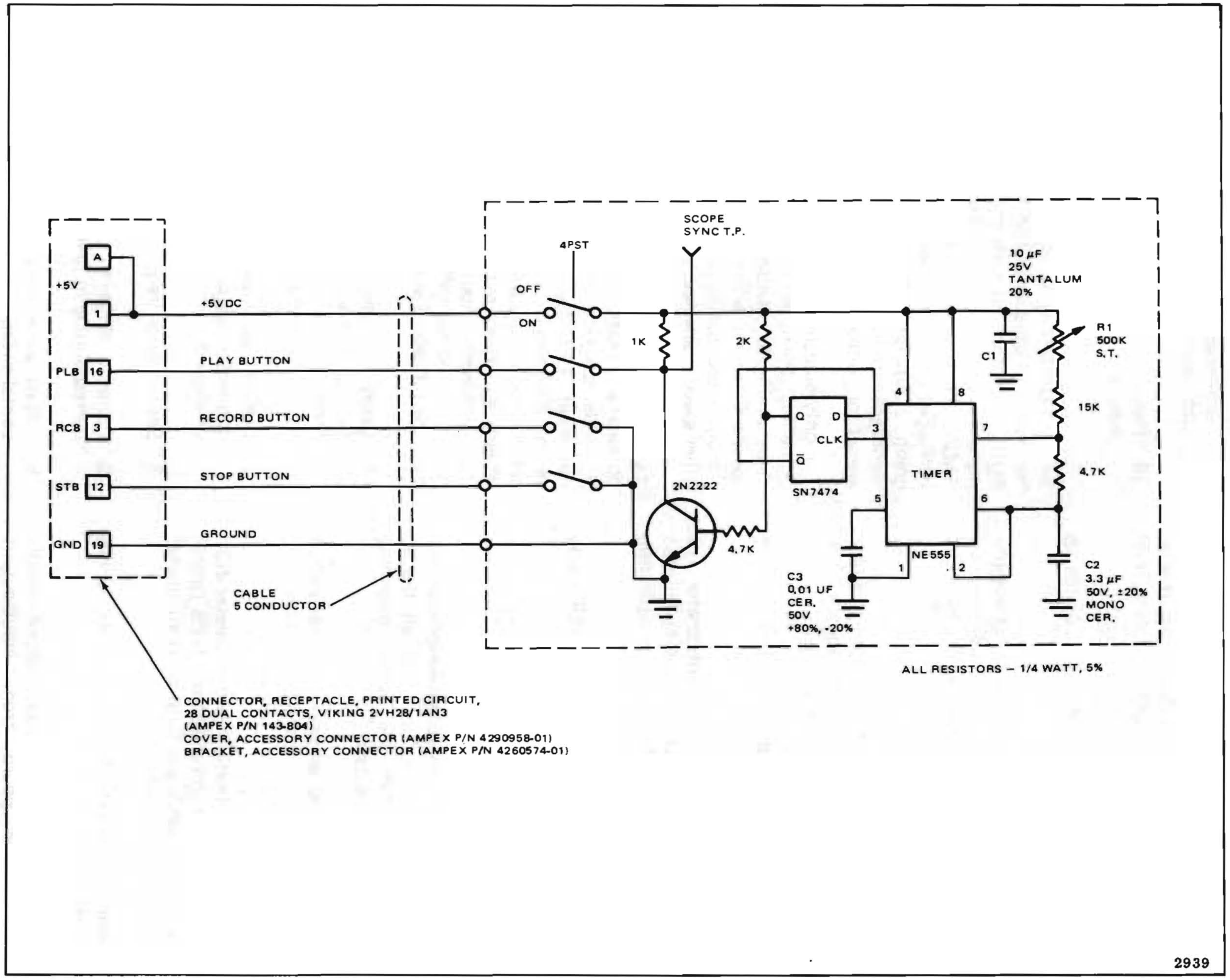



Figure 5-19. Automatic Record/Play Cycler

6. Apply power and thread a reel of tape on transport and place system into thread mode.

7. Place all channels into record mode at the speed most commonly used.

8. Adjust oscillator output level for system operating level; −5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

9. Set tape timer display to zero and record continuously for five minutes.

10. Rewind tape to tape-timer zero.

11. Remove power and place Audio PWA of channel to be aligned on an extender board and reinstall into electronics assembly.

12. If automatic cycler is being used, connect cycler to external remote control connector J11 (Figure 2-13) and trigger scope from scope sync test point on cycler.

13. Change oscillator frequency to 1.5 kHz.

14. Reapply power and place system into play mode with channel being adjusted in ready mode and other channels in safe mode.

15. If cycler is being used, turn cycler power on and adjust cycle rate time control R1 on cycler to show ingoing and outgoing edges of insert on scope. Adjust PURC timing control R71 on Main Audio PWA (Figure 5-12) to minimize overlap on ingoing insert consistent with minimum gap on outgoing edge, as viewed on scope.

16. If cycler is not being used, perform insert edits manually. While in play mode, press and hold record pushbutton switch and then press and hold stop pushbutton switch. While still holding the record and stop pushbutton switches depressed, slowly press and release play pushbutton switch (system enters record mode when play pushbutton is depressed), and adjust R71 for condition described in step 15. Repeat pressing of play pushbutton switch, and adjust R71 as required to achieve conditions described in step 15.

17. Change transport speed to second speed and perform several insert edits (step 15 or 16). If necessary, readjust R71 for best compromise. Note: if only one speed will be used for PURC operation, then optimize operation at that speed.

18. Repeat steps 2 through 16 for other channel(s) selected for PURC operation.

19. Remove power and remove extender board from electronics assembly. Reinstall audio PWA into electronics assembly.

20. If automatic cycler was used, disconnect cycler from J11.

21. Disconnect audio oscillator from audio input connector.

### 5-63. Tape Transport Adjustment

Tape transport adjustments consist of the following:

| | |
|---|---|
| Capstan Tach Sensor | Tape Lifters |
| Tension Arm Limits | Head Gate |
| Tape Tension | Tape Peeler |

**5-64. Capstan Tach Sensor.** Use the following procedures to check the operation of the capstan Tach Sensor PWA (Figure 5-20) and Capstan Tach LED PWA (Figure 5-48) and, if required, adjust the position of the Capstan Tach Sensor PWA (steps 13 through 29). Normally an adjustment is required if the capstan motor "runs away" or if the Capstan Tach Sensor PWA or Capstan Tach LED PWA is replaced. Proceed as follows:

1. Remove tape from recorder/reproducer.

2. Remove power and unplug Reel Servo PWA 9 within the electronics assembly (disables reel servo so that reel motors do not operate).

3. Place Capstan Servo PWA No. 8 on an extender board and install into electronics assembly.

4. Connect a dual trace scope to TP5 and TP6. Adjust scope for chop mode and trigger scope from either one of the two signals.

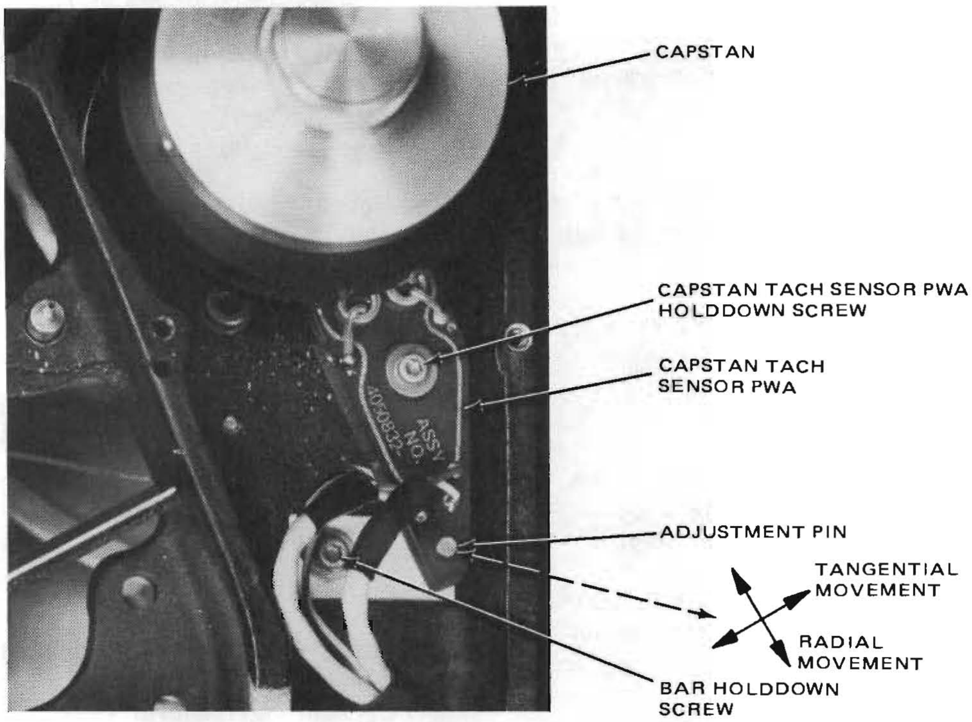



**Figure 5-20. Capstan Tach Sensor Adjustment**

5. Apply power and press play pushbutton switch. Amplitude of sine wave signals on scope should be approximately 15 Vp-p. Note: The signal at TP6 will appear distorted because of hysteresis (distortion near the zero crossings).

6. Connect scope to TP3 and TP4. Adjust scope for chop mode and trigger scope from either one of the two signals.

7. The two signals should be 90° out of phase (Figure 5-21A or Figure 5-21B).

8. Check for the correct 90° phase relationship by pressing the stop pushbutton switch, and observe that the capstan quickly stops.

9. Press fast forward pushbutton and observe that the phase relationship of signals at TP3 and TP4 remain fairly constant as the capstan accelerates to full speed.

NOTE

**If scope chop rate is too slow to observe the phase relationship, switch scope to algebraically add mode to observe the waveform (Figure 5-21D). The waveform shelves and spaces should be stable and not disappear or close.**

10. Press stop pushbutton and observe that capstan quickly stops.

11. Repeat steps 9 and 10 in rewind mode.

12. If the preceding measurements of amplitude and phase were correct, but the capstan ran faster when the stop pushbutton was pressed, the Capstan Servo PWA No. 8 may have a malfunction or the Capstan Tach Sensor PWA position may need to be adjusted to obtain the opposite 90° phase relationship of the signals at TP3 and TP4 (see Figure 5-21) and steps 13 through 29). If any of the previous

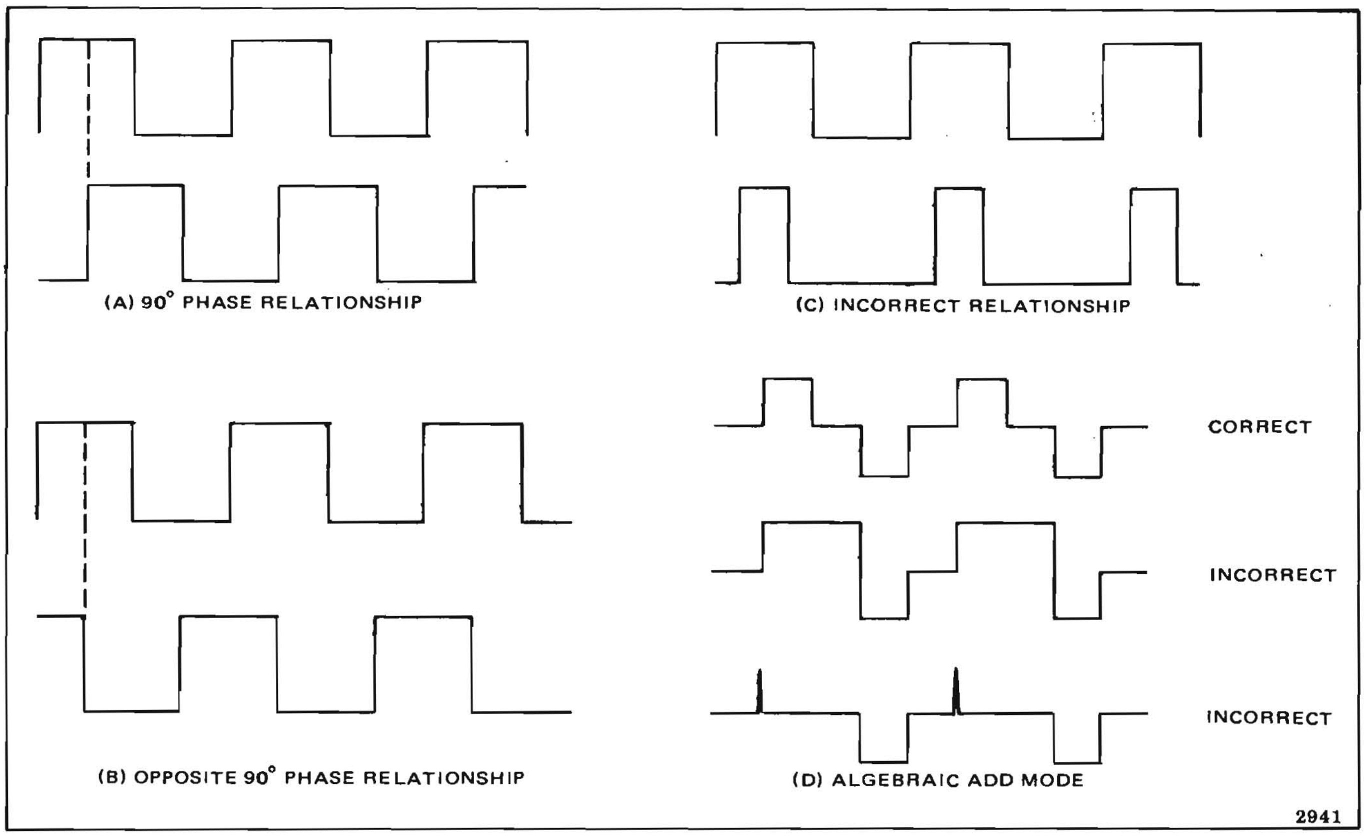



**Figure 5-21. TP3 and TP4 Waveforms, PWA 8**

conditions were not met, proceed to adjust the position of the Capstan Tach Sensor PWA to obtain tach signals of proper amplitude and phase relationship by performing steps 13 through 29.

13. Remove the head cover assembly and head assembly from the top of the transport.
14. Remove the transport front overlay panel from the top of the transport by removing two screws (Figure 5-23).
15. Remove front tach cover panel by removing one flat-head screw and banana plug shown in Figure 5-22.
16. Connect dual trace stope to TP5 and TP6. Adjust scope for chop mode and trigger scope from either one of the two signals.
17. Loosen the two holddown screws shown in Figure 5-20, but so there is still some tension against the lock washers.

### CAUTION

**FOR THE ADJUSTMENT THAT FOLLOWS AND WHILE THE TWO SCREWS ARE LOOSE (STEP 17), DO NOT PERMIT PWA TO CONTACT THE ROTATING CAPSTAN TACHOMETER AS DAMAGE TO THE TACHOMETER COULD OCCUR.**

18. Carefully move adjustment pin (Figure 5-20) tangentially (left and right) and radially (in and out) to the capstan to obtain maximum output at TP5 and TP6.
19. Adjust potentiometers R32 and R50, on Capstan Servo PWA 8, to obtain a 15-Vp-p signal (approximately) at TP5 and TP6, respectively.
20. Connect scope to TP3 and TP4. Use chop mode and trigger scope from either one of these two signals.
21. Carefully move adjustment pin a very small amount radially (only) from the capstan to

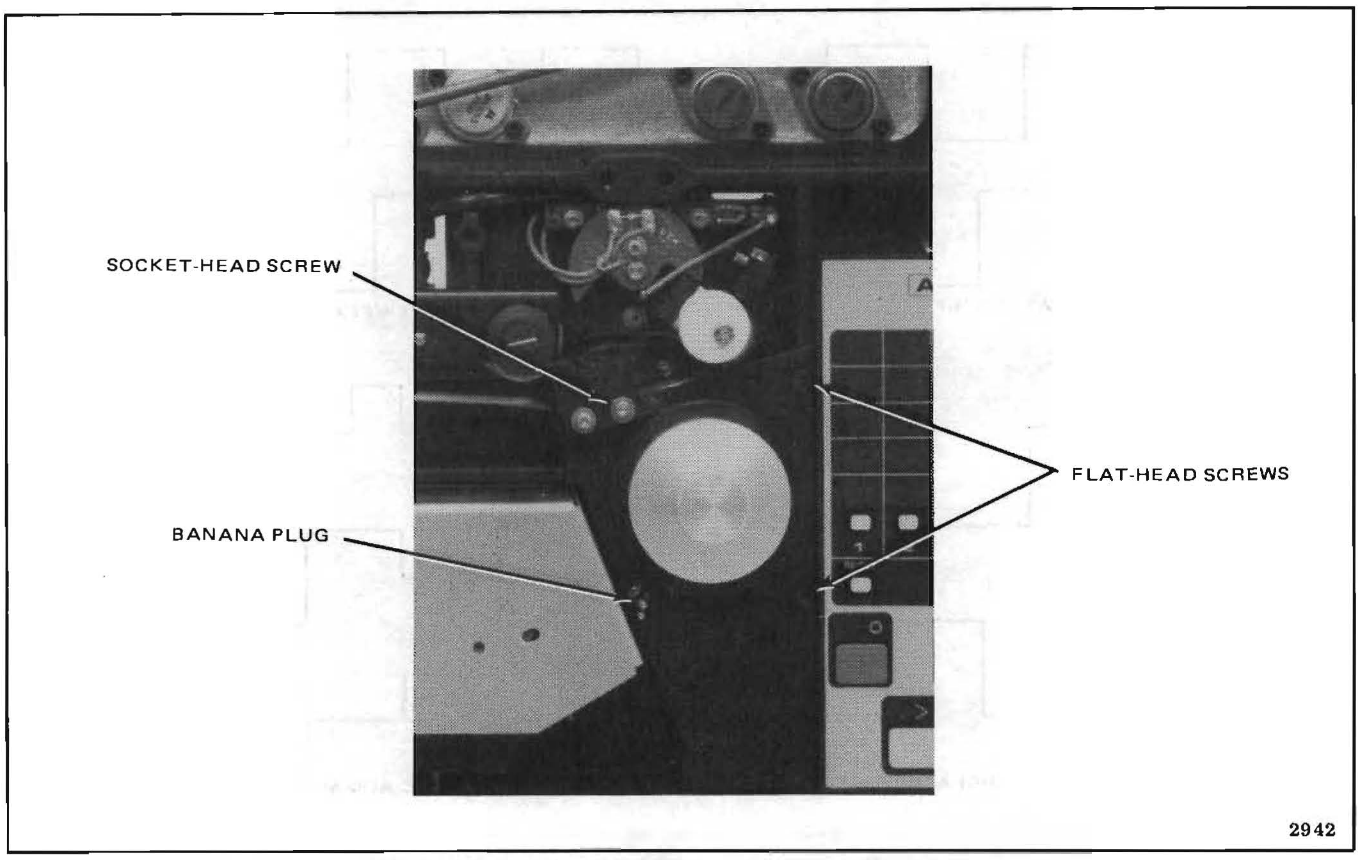



**Figure 5-22. Front and Rear Tach, Cover Panel Removal**

obtain a 90° phase difference between the two signals (Figure 5-21A or 5-21B).

22. Check for the correct 90° phase relationship by pressing the stop pushbutton switch and observing if the capstan quickly stops. If capstan quickly stopped, proceed to step 24; otherwise perform step 23.

23. If capstan ran faster when stop pushbutton was pressed, press rewind pushbutton to stop capstan and then press play pushbutton. Readjust adjustment pin radially (only) for a 90° phase relationship opposite to that previously observed in step 21.

**NOTE**

**Capstan may have to be held by hand to prevent runaway at high speed before proper phase is found. If desired, capstan motor connector P18 (Figure 5-27) may be temporarily disconnected and capstan rotated by hand until the proper phase relationship is found.**

24. After correct phase is established, first tighten the bar holddown screw, and then tighten the Capstan Tach Sensor PWA holddown screw (Figure 5-20).

25. Connect scope to TP5 and TP6. Use chop mode and trigger scope from either one of the two signals.

26. Verify that the level set while performing step 19 has not changed. If level has changed, repeat step 19.

27. Further confirm the correct 90° phase relationship by performing steps 6, 9, 10 and 11.

28. Remove power and reinstall Reel Servo PWA No. 8, Capstan Servo PWA No. 9, tach cover panel, transport front overlay panel, head assembly, and head cover assembly.

29. Reconnect capstan motor connector P18 (if disconnected).

**5-65. Tension Arm Limits.** During recorder/reproducer operation, if a condition exists where either tension arm moves too far in toward the head assembly or too far out toward the reels, the recorder should enter stop/edit (unthread) mode. The supply and takeup potentiometers sense the arm position and cause the recorder to enter stop/edit mode just before the arm reaches its mechanical stop. If the recorder/reproducer fails to meet the tests that follow, adjust the position of the associated LED PWA. The enlarged mounting hole of the LED PWA permits movement of the LED PWA on the tension arm. Proceed as follows:

1. With power off, place Reel Servo PWA No. 9 on an extender board and reinstall into electronics assembly.

2. Connect a scope probe or dc voltmeter to outer limit test point TP5 of Reel Servo PWA.

3. With no tape on transport, apply power and hold both tension arms in mid position of travel. Indication should be high (+5 Vdc).

4. Hold both arms in mid position, and then release supply arm. Indication should go low (0 Vdc).

5. Hold both arms in mid position, and then release takeup arm. Indication should go low (0 Vdc).

6. Connect scope probe or dc voltmeter to inner limit test point TP6.

7. With both arms resting in the outer position, indication should be high (+5.0 Vdc).

8. Move supply arm in toward head. Indication should be low (0 Vdc).

9. With supply arm resting in outer position, move takeup arm in toward head. Indication should be low (0 Vdc).

10. If any of the preceding conditions were not met, proceed as follows:

    a. Remove head cover assembly and transport rear overlay panel (Figure 5-23).

    **CAUTION**

    **REMOVE POWER BEFORE ADJUSTING THE POSITION OF AN LED PWA. ALSO DO NOT ALLOW METAL LUG UNDER AN LED HOLDDOWN SCREW TO SHORT AGAINST CIRCUIT TRACES ON THE PWA.**

    b. Loosen the appropriate LED PWA holddown screw (Figure 5-24) and rotate the PWA relative to the tension arm. Tighten screw.

    c. Place overlay panel loosely in place to prevent ambient light affecting photopotentiometer operation.

    d. Repeat steps 2 through 10c, as necessary.

    e. Reinstall rear overlay panel and head cover assembly removed in step 10a. Verify that rear overlay panel does not interfere with the free rotation of the tension arms.

11. If any adjustments were made to the position of the LED PWAs, perform the *Tape Tension* adjustment procedure, paragraph 5-66.

**5-66. Tape Tension.** Adjust tape tension if tape should creep in either direction in stop mode or after changing or adjusting any component associated with the reel servo system. Proceed as follows:

1. Remove head cover assembly, and transport front overlay panel (Figure 5-23).

2. With power off, place Reel Servo PWA No. 9 (Figure 5-25) on an extender board.

3. Thread tape on recorder/reproducer and advance tape so there is equal tape pack on both reels.

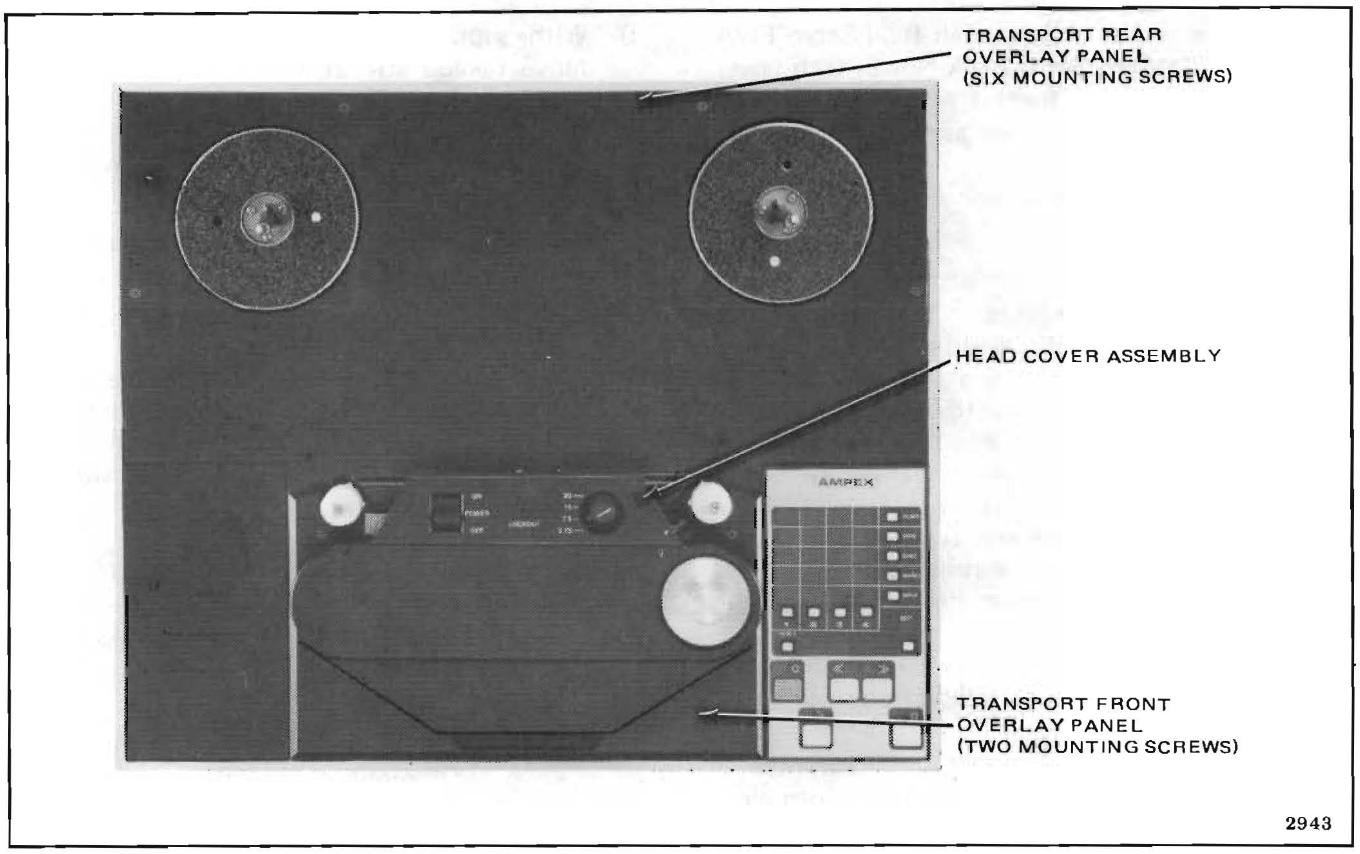



**Figure 5-23. Head Cover and Overlay Panels**

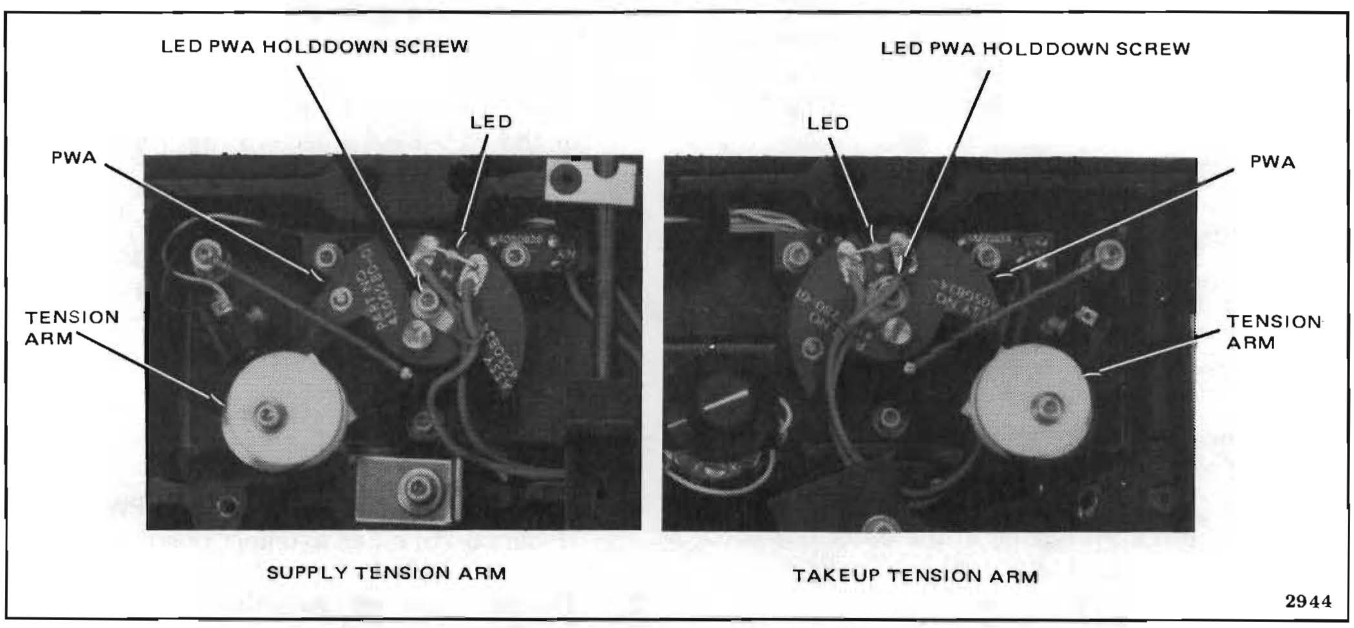



**Figure 5-24. Tension Arm Limits Adjustment**

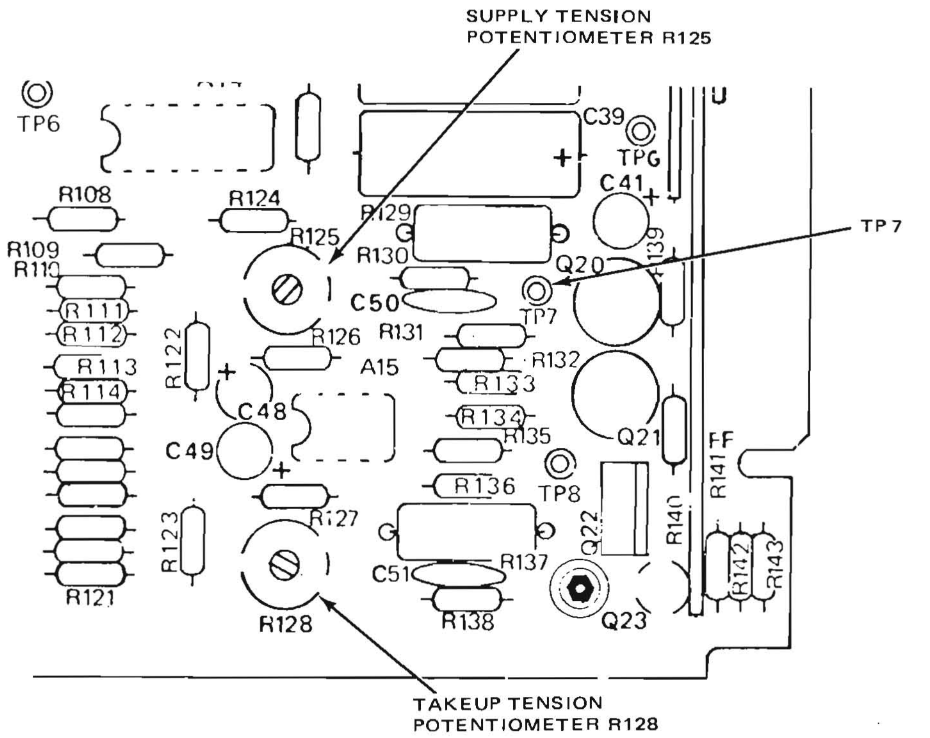



**Figure 5-25. Tape Tension Adjustment Controls, PWA No. 9**

4. With tape speed set to 7.5, 15, or 30 in/s, place recorder/reproducer into play mode.

5. Place Tentelometer tension sensor arms to straddle tape at the supply side of the capstan (between capstan and head assembly) as shown in Figure 5-26. (If Tentelometer is not available, connect dc voltmeter to TP7 on PWA No. 9.)

6. Observe tape tension on Tentelometer gauge. Tension should be 3.75 ounces for 1/4-inch tape, or 7.5 ounces for 1/2-inch tape.

7. If tension is not as specified, adjust supply tension potentiometer R125 for 3.75 ounces for 1/4-inch tape, or 7.5 ounces for 1/2-inch tape. Press stop pushbutton switch.

8. Press play pushbutton and then press EDIT pushbutton to enter play/edit mode. Then press stop pushbutton. Capstan should stop and remain stopped with no tendency to turn in either direction. If capstan creeps in either direction, slightly readjust supply tension potentiometer R125.

9. Press EDIT pushbutton to cancel play/edit mode. Rethread tape and place system into thread mode. Manually spin capstan edit knob in one direction and then the other direction with equal force. Tape should coast approximately an equal amount in each direction before coming to a stop. If tape does not coast an equal amount, adjust takeup tension potentiometer R128 as required.

**5-67. Tape Lifters.** Use these instructions to adjust the tape lifter solenoid and the position of the tape lifter arms.

2946

Figure 5-26. Measuring Tape Tension

**5-68.** *Tape Lifter Solenoid.* When the tape lifter solenoid is energized or de-energized, trapped air between the plunger and solenoid housing is permitted to leak out slowly to provide slow and smooth tape-lifter action. Unless the tape lifter arms and cable linkage have been disassembled, the only adjustment that may be required is the solenoid air leak control. Proceed as follows:

1. Disconnect capstan motor connector P18 (Figure 5-27).

2. Thread tape on transport and place recorder/reproducer into fast forward mode (tape will not move as capstan motor is disconnected).

### CAUTION

**WHILE PERFORMING THE NEXT STEP, BE CAREFUL NOT TO SHORT THE SOLENOID POWER TERMINALS.**

3. Adjust the tape lifter solenoid air-leak screw (Figure 5-27) for fast, smooth tape-lifter action when EDIT pushbutton is alternately pressed and released. The solenoid should take approximately 0.5 second to lift or retract tape. (Note: the air-leak screw has a thread-locking device and is held in place by friction.)

4. Reconnect capstan motor connector P18.

**5-69.** *Tape Lifter Arms.* The tape lifter arms must retract clear of the tape surface in stop and play/record modes (solenoid de-energized). The tape lifters can be adjusted to permit information on the tape to be monitored by the reproduce or record head (sel-sync mode) while in fast forward, rewind, or spool modes. (Note: The tape does not actually contact the heads in fast modes when the tape lifters are properly adjusted.)

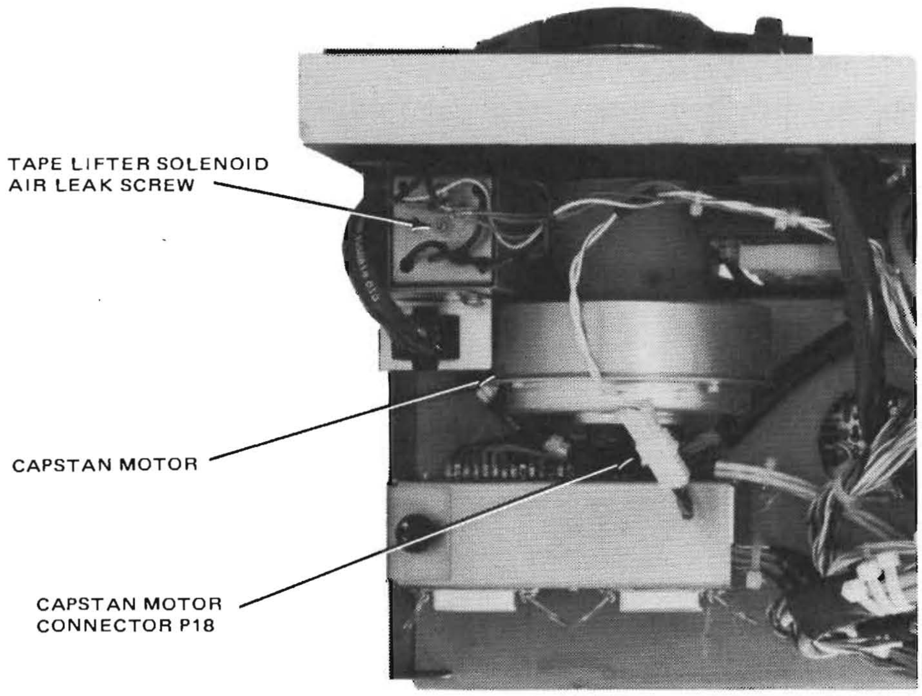



**Figure 5-27. Tape Lifter Solenoid Adjustment Screw, Right Side of Tape Transport**

If one or both tape-lifter arms contact the tape when solenoid is de-energized, perform steps 1, 2 and 3. If tape monitoring in fast forward, rewind, and spool modes is unsatisfactory, perform steps 4 through 10. Proceed as follows:

1. With power off, thread tape onto transport.

2. Loosen two button-head screws (Figure 5-28) that hold the tape-lifter solenoid shield to the solenoid.

3. Slide the shield toward the head assembly to retract both lifter arms further from the tape, or slide the shield away from the head assembly to advance the arms toward the tape. While maintaining tape tension, adjust the shield position so that there is approximately 1/32-inch clearance between the arms and tape. Tighten the shield button-head screws and recheck clearance.

NOTE

**For the following steps, tape lifters are to be set such that while in fast forward, rewind, and spool modes, tape does not actually contact the heads or contact the scrape flutter idler, causing it to rotate. Also tape lifters must not lift tape so far from heads so as to lose contact with the upper and lower tape-edge ceramic guides shown in Figure 1-3.**

4. Thread a prerecorded tape on to the transport, select play mode, and adjust signal levels for normal play mode operation. Press stop pushbutton.

5. Loosen the 6-32 cap screw in the tape-lifter roller (Figure 5-28) nearest the tape-lifter solenoid. Then lightly tighten the screw to provide limited holding power against the tape lifter shaft.

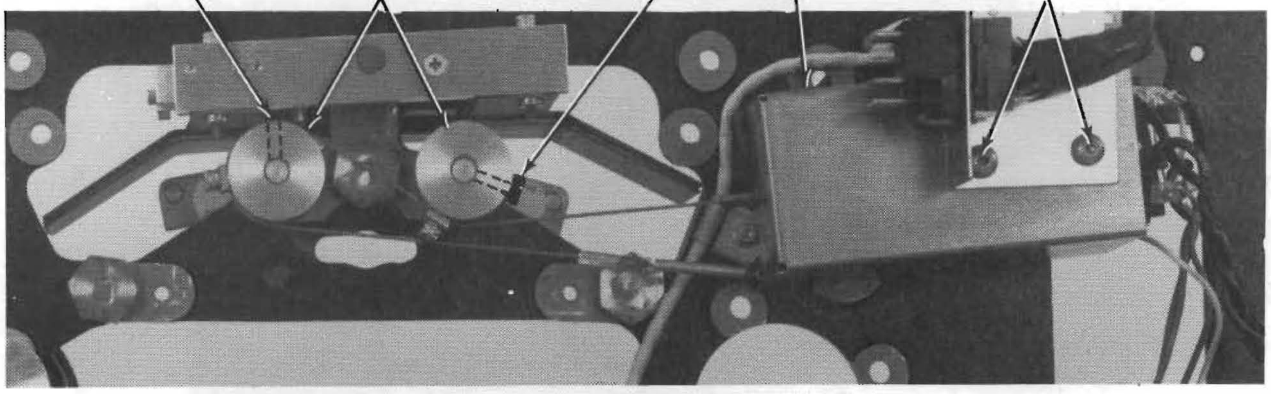



**Figure 5-28. Tape Lifter Rollers and Solenoid, Rear View of Transport**

### CAUTION

**IN THE FOLLOWING STEP, DO NOT OVERTIGHTEN ROLLER SCREWS, AS DAMAGE TO THREADS MAY OCCUR.**

6. Place system into spool mode.

7. Turn lifter shaft nearest the reproduce head, with respect to the roller, to obtain the desired audio level for monitoring purposes.

8. Before tightening cap screw, use a paper shim (about the thickness of this manual page) to establish clearance and prevent binding between the roller and the lifter bushing that is attached to the transport casting. Tighten cap screw while holding roller against paper shim.

9. Select stop mode.

10. Loosen the 6-32 setscrew in the roller (Figure 5-28) furthest away from the tape-lifter solenoid. Then lightly tighten the screw to provide limited holding power against the tape lifter shaft.

11. Place system into sel-sync mode, and transport into spool mode.

12. Turn lifter shaft nearest erase head, with respect to the roller, to obtain an audio level comparable to that set for the reproduce head in step 7.

13. Before tightening setscrew, use a paper shim (about the thickness of this manual page) to establish clearance and prevent binding between the roller and the lifter bushing that is attached to the transport casting. Tighten setscrew while holding roller against paper shim.

14. Check results while operating in spool mode and switching between repro and sync monitoring modes. Readjust lifter shaft positions if necessary.

15. While in spool mode, visually inspect tape path to check that tape does not touch any head stack or the scrape flutter idler(s), and is within the ceramic tape guides.

**5-70. Head Gate.** The movable head gate (Figure 5-29) shields the head assembly from electromagnetic interface pickup when the recorder/reproducer is in operation. The head gate does not normally need adjustment but, if required, perform the applicable adjustment procedure.

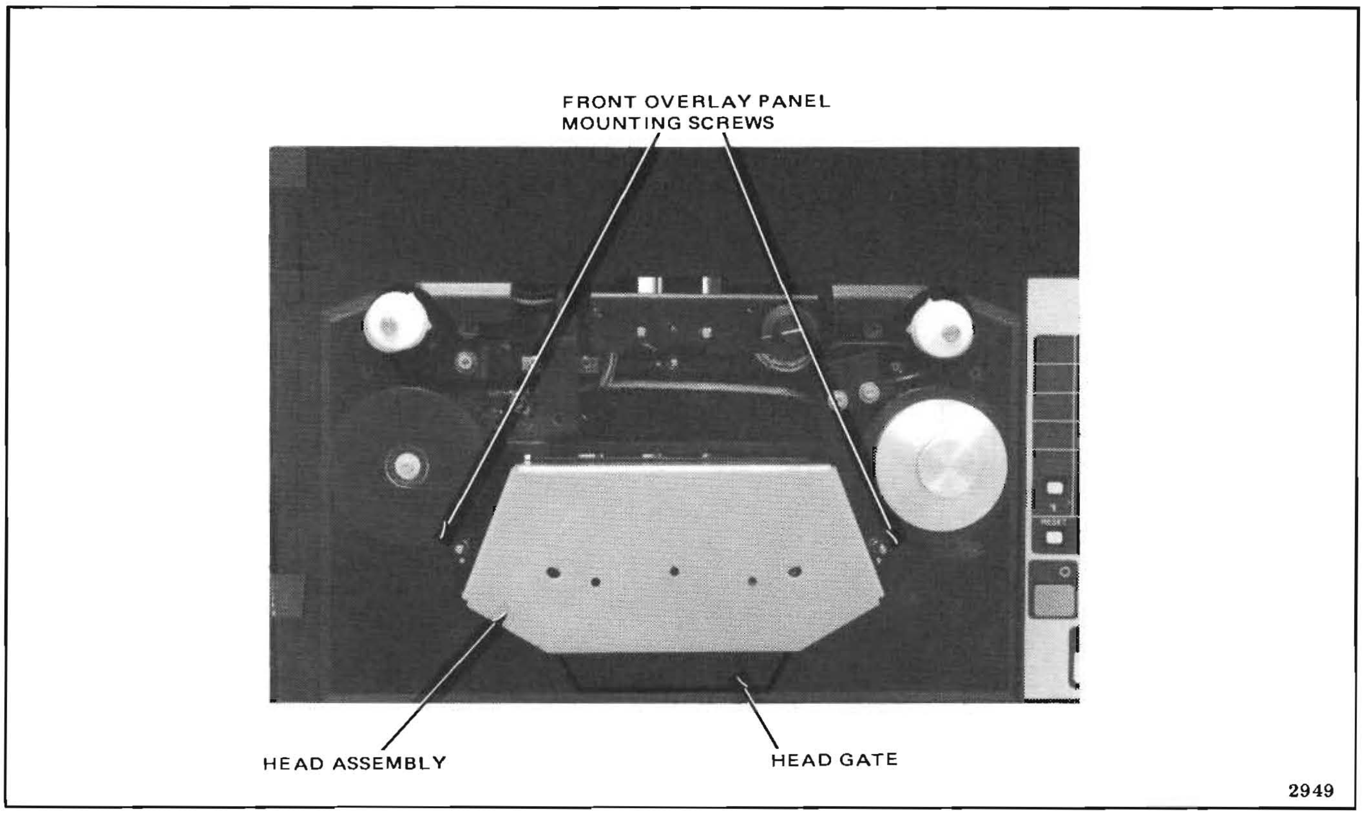



**Figure 5-29. Top View of Transport, Head Cover Removed**

NOTE

**All head gate adjustments are made with power off.**

**5-71.** *Head Gate Height in Latched Position.* When pressed down, the gate should latch in a position low enough to permit easy removal of tape from the head assembly without catching on the head gate shield. However, the gate must not be too low to prevent the head gate catch (Figure 5-30) from being unlatched. To set head gate height in latched position, proceed as follows:

1. Remove head cover assembly and front overlay panel (Figure 5-23).

2. With tape threaded on transport and head gate in latched (down) position, check that tape can easily be removed from head assembly without catching on head gate shield. If necessary, adjust head-gate height adjustment setscrew (Figure 5-30) [Turning setscrew counterclockwise one turn raises head gate latched position 0.03 inch (0.76 mm).]

3. After head gate height is adjusted, check gate operation as follows:

   a. Reinstall front overlay panel.

   b. Press head gate down to latched (down) position.

   c. Press head gate down again to verify that head gate catch unlatches allowing head gate to rise. If catch does not unlatch, height may be set too low. Remove front overlay panel and repeat steps 2 and 3 as necessary. If height appears correct but latch does not operate properly, check head gate catch operation (paragraph 5-73).

4. Reinstall front overlay panel and head cover assembly.

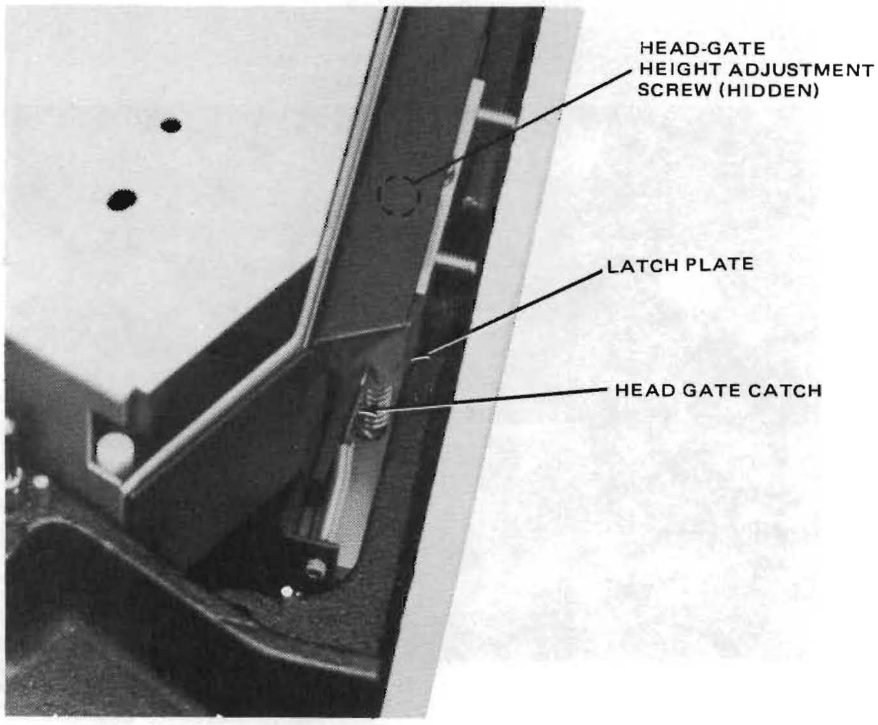



**Figure 5-30. Head Gate in Latched (Down) Position**

**5-72.** *Head Gate Shield Alignment with Head Assembly Shield.* When the head gate is in the unlatched (up) position, the shield of the head gate must close against the shield of the head assembly, especially in the area of the record and reproduce head. Proceed as follows:

1. Place head gate in the unlatched (up) position, and observe head gate shield alignment with head assembly shield.

2. If required, loosen shield-securing screw shown in Figure 5-31 and slightly raise or lower right-hand side of shield (as viewed from the front of recorder/reproducer) to align head gate shield with head shield. Tighten screw.

**5-73.** *Head Gate Catch.* The head gate latch is a push-to-set and push-to-release type of latch. The free end of the wire catch must rest in the proper location for the latch to function properly. When the head gate is in the unlatched (up) position, the free end of the wire catch must nearly contact the face of the latch plate at the location shown in Figure 5-32. Align the wire head gate catch as follows:

1. Remove head cover assembly and front overlay panel.

2. With the aid of a long-nose pliers, slightly bend screw through spring at location shown in Figure 5-32, left or right, as required, so that wire catch rests at location shown (Figure 5-32) when gate is in the unlatched (up) position.

3. Check previous adjustment by operating head gate to the latched (down) and unlatched (up) position. Repeat step 2 as necessary.

4. Reinstall front overlay panel and head cover assembly.

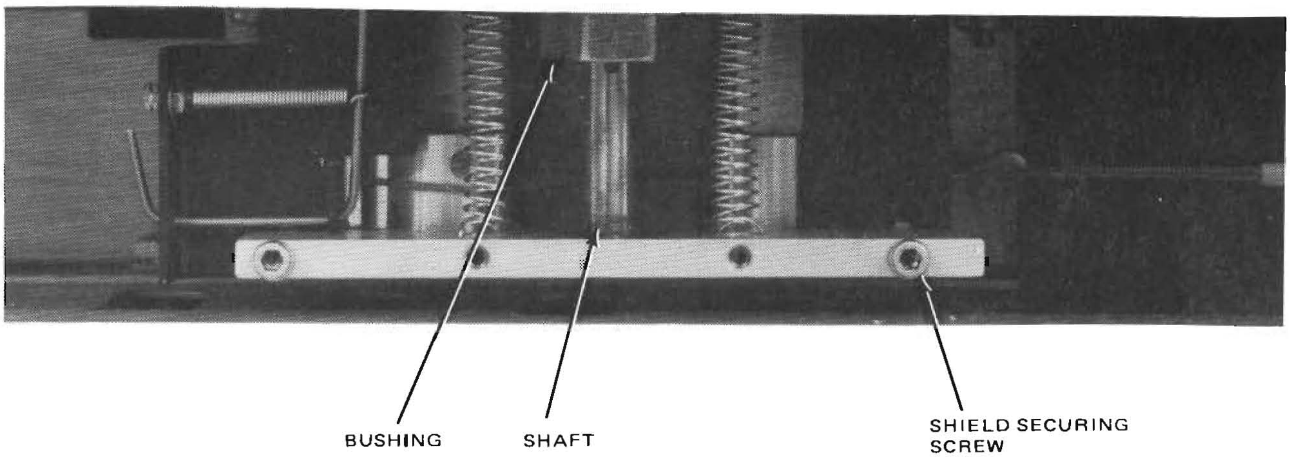



Figure 5-31. Head Gate in Latched (Down) Position, Front View of Transport

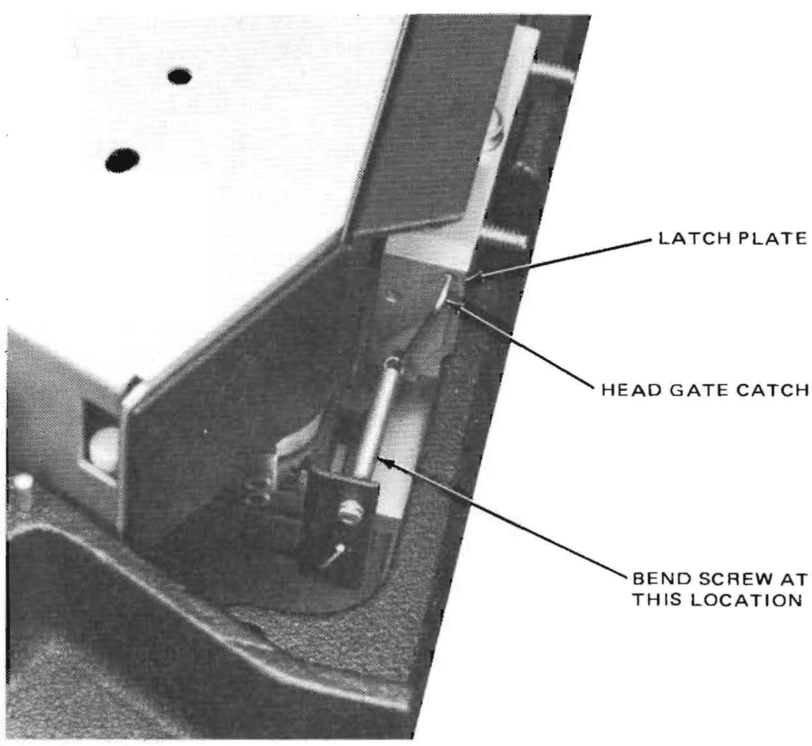



Figure 5-32. Head Gate in Unlatched (Up) Position

**5-74.** *Head Gate Vertical Alignment.* In operation, the head gate should not rub on the head assembly or on the front overlay panel. If the head gate does rub on either surface, there may not be enough restoring force in the head gate return springs to fully close the head gate shield against the head assembly shield. Proceed as follows:

1. Operate the head gate and note if the head gate rubs against the head assembly shield or the front overlay panel.

2. If rubbing is noted, remove the head cover assembly and head assembly.

3. With head gate in the unlatched (up) position, carefully bend head gate toward or away from transport as required so that head gate clears front overlay panel with minimum clearance.

4. Reinstall head assembly and check head gate operation for no rubbing.

**5-75. Tape Peeler.** For proper spilling of tape in the play/edit mode, the tape peeler must be correctly positioned. Proceed as follows:

1. Loosen the two tape peeler mounting screws shown in Figure 5-33.

2. Position the tape peeler so that the following conditions are met:

   a. There is 1.0 to 4.0 mils clearance between the edge of the peeler and the capstan. (A piece of recording tape can be used as a shim.)

   b. When the tension arm idler is pressed against the peeler (Figure 5-33), the

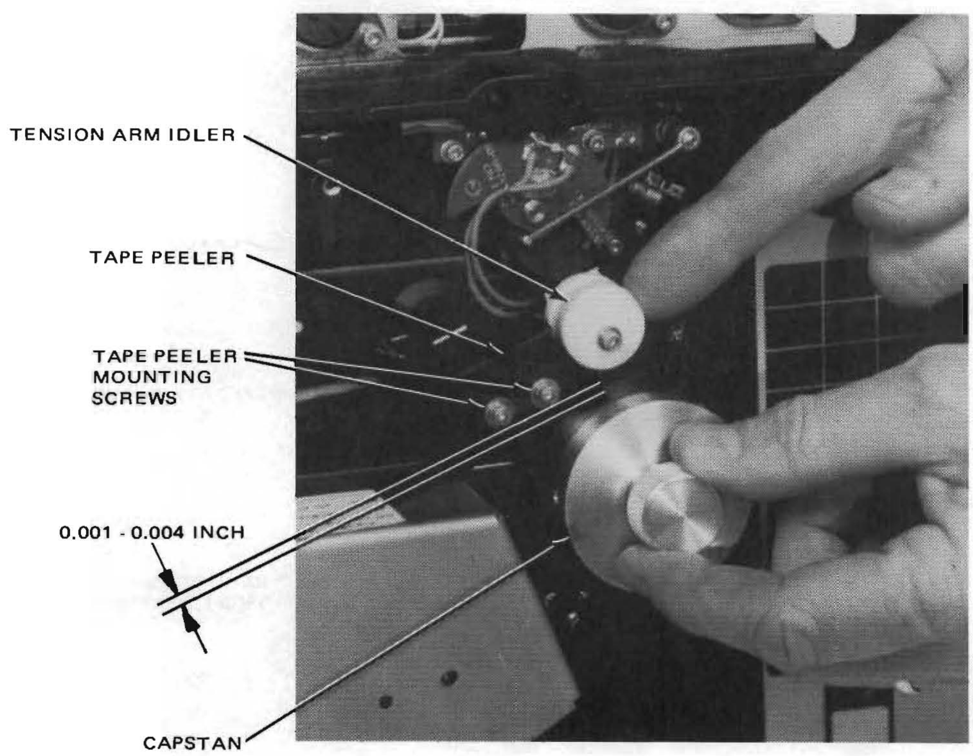



**Figure 5-33. Tape Peeler Adjustment**

rubber idler is slightly compressed against the capstan, and when released, the arm returns to its rest (up) position.

3. Tighten the two tape peeler mounting screws.

4. Verify that the inner electrical limit circuitry associated with the takeup tension arm is still operational. Check operation by performing steps 1, 7, and 10 through 12 of the *Tension Arms Limits* adjustment procedure, paragraph 5-65.

## 5-76. PERFORMANCE TESTS

Use the following performance test procedures to check tape tension, absolute tape speed accuracy, speed variation, operating level, signal-to-noise ratio, harmonic distortion, intermodulation distortion, and flutter. The performance test should be performed after each 500 hours of operation to ensure the recorder/reproducer is performing in accordance with the specifications given in Table 1-4. Also, an applicable performance test should be performed whenever the equipment appears to be malfunctioning and following repairs to the equipment that could affect performance.

Test equipment required for the performance tests is listed in Table 5-1. In the event a performance test is unsatisfactory, refer to the troubleshooting section of the manual (paragraph 5-89) and perform the appropriate alignment, adjustment, or corrective maintenance procedure.

### 5-77. Tape Tension

If tape should creep in either direction while in stop mode, or tape tension appears to be incorrect, check tape tension as follows:

1. Remove head cover assembly and the front overlay panel (two screws).

2. Thread tape on recorder/reproducer with approximately even tape pack on both reels.

3. With tape speed set to speed most commonly used, place recorder/reproducer into play mode.

4. Place Tentelometer tension sensor arms to straddle tape at the supply side of the capstan (between capstan and head assembly) as shown in Figure 5-26. (If Tentelometer is not available, see alternate procedure using a dc voltmeter given in paragraph 5-61, steps 2, 5, and 6.)

5. Observe tape tension on gauge. Tension should be 3.75 ±0.5 ounces for 1/4-inch tape, or 7.5 ±0.5 ounces for 1/2-inch tape. Remove Tentelometer and press stop pushbutton switch.

6. Manually spin capstan edit knob in one direction and then in the opposite direction with equal force. Tape should coast an equal amount in each direction.

### 5-78. Absolute Tape-Speed Accuracy

The absolute tape speed of the recorder/reproducer refers to the inches of tape that travels past the reproduce head per unit of time. If the tape tensions are correctly adjusted, there will be no tape slippage at the capstan. Therefore the capstan peripheral velocity may be considered a direct indication of absolute tape speed. The capstan is precisely manufactured to have a diameter of 2.3854 ±0.0002 inches (±0.008%). Since this tolerance is very small, absolute tape speed can be determined by measuring the frequency of the capstan tachometer signal while the capstan rotates for 30-in/s operation during a precise unit of time. If desired to measure the capstan diameter, the measuring gauge used should be adequately calibrated consistent with the tolerance to be measured.

To determine absolute tape speed, proceed as follows:

1. Select 30-in/s tape speed. If system is not set up for 30-in/s operation, temporarily enable 30-in/s operation as follows:
   a. Remove power.
   b. Unplug all audio channel PWA's within the electronics assembly.
   c. If recorder/reproducer has been set up for two-speed master bias operation

(instead of four-speed master bias operation as shipped from the factory), remove Audio Control PWA No. 5 from electronics assembly. Place jumper J1 (Figure 5-6) in the 30-in/s position. Reinstall PWA No. 5 into electronics assembly.

2. With power off, place Capstan Servo PWA No. 8 on an extender board and reinstall into electronics assembly.

3. Use a shielded lead to connect a counter (Table 5-1) to TP1 and ground on PWA No. 8 to measure capstan tachometer rate.

4. Apply power, thread reel of tape on transport, and place system into play mode.

5. Counter should read 9,600 Hz, which is the tach frequency at 30 in/s.

6. Set counter to read a 10-second interval count. The measured count should be 96,000 ±6 counts. This corresponds to an absolute capstan rotational accuracy of ±0.006%. The combined speed error caused by the capstan diameter and capstan rotational speed error is the total speed error. Note: Counter accuracy is limited to ±1 count in the least significant digit.

7. If applicable, remove power and restore jumper J1 on PWA No. 5 to original position. Reinstall audio PWA's within electronics assembly.

8. Remove power and reinstall Capstan Servo PWA No. 8 into electronics assembly.

**5-79. Speed Variation**

To measure speed variation, tape speed is measured at the beginning of a reel and is compared to the speed near the end of the reel. This is accomplished by recording and playing back a stable reference frequency and comparing any difference in frequency count over a precise unit of time. To check speed variation, proceed as follows:

1. With power off, place Capstan Servo PWA No. 8 on an extender board and reinstall into electronics assembly.

2. If an input/output assembly is being used, use a shielded audio lead and connect TP1, on the Capstan Servo PWA, to a channel input of the input/output assembly. (Note: TP1 supplies a stable reference signal and the frequency of this signal is 9,600 Hz at 30 in/s, 4,800 Hz at 15 in/s, 2,400 Hz at 7.5 in/s, and 1,200 Hz at 3.75 in/s.)

3. If an input/output assembly is not being used, use a shielded audio lead and connect TP1 of the Capstan Servo PWA to a channel input of the recorder/reproducer at connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3). Connect signal input of a frequency counter to the same channel output on connector J13 or J14 (Figure 2-13).

4. To detect worst case speed variation, use 7-inch diameter EIA reels with a small hub (NAB type B reels) in the supply and takeup position. Apply power, thread a full reel of tape on transport, and place system into thread mode.

5. Select input mode for channel being used and the highest tape speed that recorder/reproducer has been set up for.

6. Place system into record mode and record for approximately two minutes.

7. While recording, set counter to display a 10-second interval count and note reading.

8. Stop recording, turn the reels over end-for-end (interchange reels), and place system into thread mode.

9. If recorder/reproducer is other than a full-track system, reconnect frequency counter to appropriate channel output so recording made in step 6 may be reproduced.

10. Select repro mode for channel being used and place system into play mode.

11. With counter set to display a 10-second interval count, the total count played back in 10 seconds should be within 9 counts of the input count at 30 in/s, 4 counts at 15 in/s, or 2 counts at 7.5 in/s.

12. Remove power and reinstall Capstan Servo PWA No. 8 into electronics assembly.

### 5-80. Operating Level

To determine or check the operating level of the recorder/reproducer, play back a standard alignment tape. Preferably use an alignment tape that has the same track format as the recorder/reproducer (full track, 2 track, or 4 track). If this type of alignment tape is not available and a full-track alignment tape is used on a multitrack recorder/reproducer, refer to the amplitude correction factors given in Table 5-4. (Refer to *Use of Alignment Tapes/General Discussion*, paragraph 5-31, and *Operating Level/General Discussion* paragraph 5-34.)

The following procedures can be used to determine recorder/reproducer operating levels of 370 nWb/m, 260 nWb/m, or 185 nWb/m with the use of a 185-nWb/m reference level alignment tape (Figure 5-1).

NOTE

**On Ampex alignment tapes for 15 and 30 in/s, the 185-nWb/m, 700-Hz reference tone is the first tone on the tape. For 3.75 and 7.5 in/s, the 185-nWb/m, 700-Hz (500-Hz, 3.75-in/s) tone is the last tone on the tape.**

To check operating level, proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual (paragraphs 5-4 and 5-7).

2. Select system tape speed at the transport control panel.

3. If an input/output assembly is not being used, connect an ac voltmeter to appropriate recorder/reproducer output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

4. Reproduce the 185-nWb/m operating level 500-Hz tone for 3.75 in/s, or 700-Hz tone for 7.5, 15, or 30 in/s of an Ampex standard alignment tape.

NOTE

**For the following step 5 and step 6, apply amplitude correction factor (Table 5-4), if applicable.**

5. If an ac voltmeter is being used at the output of the recorder/reproducer, the operating level can be determined from the ac voltmeter reading as follows:

   a. 370 nWb/m — −11 dBm.

   b. 260 nWb/m — −8 dBm.

   c. 185 nWb/m — −5 dBm.

NOTE

**Step 6 assumes that the input/output assembly has been calibrated for a line output operating level of +4 dBm (0 vu with meter in vu position or −6 dB with meter in peak position).**

6. If an input/output assembly is being used, set the reproduce MANUAL/PRESET switch to PRESET position. The operating level, as read on an ac voltmeter or on the input/output level meter, should be as follows:

   a. 370 nWb/m — −2 dBm or −6 vu (meter in vu position) or −12 (meter in peak position).

   b. 260 nWb/m — +1 dBm or −3 vu (meter in vu position) or −9 (meter in peak position).

   c. 185 nWb/m — +4 dBm or 0 vu (meter in vu position) or −6 (meter in peak position).

### 5-81. Signal-to-Noise Ratio

The signal-to-noise ratio measurement is made using a filter connected to the output of the system to attenuate noise out of the audible-frequency band. Figure 5-34 is a simple passive filter for passing frequencies in the 30 Hz to 18 kHz frequency band and Figure 5-35 is a filter for weighting to the ANSI 'A' characteristic. If desired to use the ANSI 'A' filter shown in Figure 5-35, it is necessary to correct for the insertion loss of the filter at 1 kHz. This is accomplished by adding

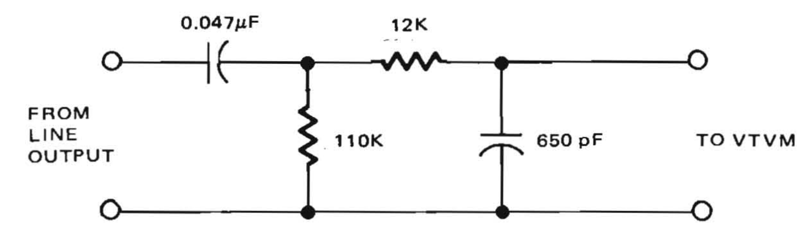



**Figure 5-34. 30-Hz to 18-kHz Band Limiting Filter**

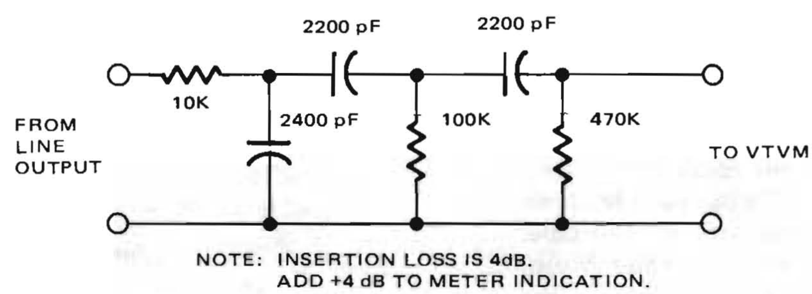



**Figure 5-35. ANSI 'A' Weighted Filter**

+4 dB to the ac voltmeter indication when making the measurement. For example, if the meter reads −61 dBm through the filter, the actual reading is −57 dBm.

Figure 5-36 is a schematic diagram of a universal noise filter (constructed by the user) that has a four-position selector switch for measurement to standards CCIR, ANSI A Weighted, and 30 - 18 kHz. The fourth position of the selector switch enables the filter to be used as a buffer. A gain switch permits unity gain or 20 dB gain.

Table 5-15 gives signal-to-noise ratios for tape speed, equalization standard, track format, and noise measurement weighting filter in use when using Ampex 456 tape (or direct equivalent), and with the recorder adjusted for 370-nWb/m operating level at 700 Hz. Table 5-16 provides signal-to-noise ratios with the system in standby mode. All signal-to-noise ratios given in Tables 5-15 and 5-16 are measured relative to nominal 3% third harmonic distortion which is 9 dB above 370-nWb/m level when using Ampex 456 tape. The signal-to-noise ratio measurement should only be performed if the reproduce, record, and erase system alignment has been performed or is known to be correct.

To measure signal-to-noise ratio, proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.

2. If an input/output assembly is being used, connect an ac voltmeter through a band limiting filter (Figure 5-34, 5-35, or 5-36) to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).

3. If an input/output assembly is not being used, connect an ac voltmeter through a band limiting filter (Figure 5-34, 5-35, or 5-36) to appropriate output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3) and connect an audio oscillator to appropriate input connector J13 or J14.

4. Apply power and thread a reel of bulk-degaussed tape on the transport and place system into thread mode.

5. Set speed switch to tape speed selected for measurement.

6. Place system in record mode (channels not under test should also be placed in record mode).

7. Set oscillator frequency to 1.0 kHz and adjust oscillator output level for +5 dBm at the output of the recorder/reproducer, or for +14 dBm at the output of the input/output assembly. (Note: For convenience, these levels are 10 dB above operating level.)

8. Reset tape timer display to zero.

9. Record continuously for at least two minutes and rewind tape to tape timer display zero.

10. Remove oscillator and short signal input terminals (or short input with an impedance not greater than 300 ohms).

11. Again place system into record mode and read residual noise on the ac voltmeter. Calculate the signal-to-noise ratio as follows:

    a. If an input/output assembly is being used, the ac voltmeter reading should be 13 dB less than the amount (after correction for filter insertion loss) shown in Table 5-15. (This assumes input/output assembly has been aligned to provide a +4-dBm line output level for a −5-dBm interface level at operating level.) For example, if ac meter reads −62 dBm, signal-to-noise ratio is −62 plus −13 or 75 dB.

    b. If an input/output assembly is not being used, the ac voltmeter reading should be 4 dB less than the amount (after correction for insertion loss) shown in Table 5-15. (This assumes recorder/reproducer has been aligned for −5-dBm interface operating level.)

12. Press stop pushbutton to stop transport and place system into standby mode.

13. Read residual noise on ac voltmeter and compare with readings in standby signal-to-noise ratio table, Table 5-16.

14. Repeat all steps in sync monitor mode. The signal-to-noise ratio should meet or exceed all readings in Table 5-15.

### 5-82. Harmonic Distortion

It is recommended that harmonic wave levels be measured using a wave or spectrum analyzer (the use of a total harmonic distortion analyzer to measure off-tape distortion is not recommended). The audio oscillator used for measurement should not have a residual second harmonic component greater than 0.03% rms (−70 dB) for fundamental frequencies from 500 Hz to 1.0 kHz. Also the third harmonic component should not be greater than 0.05% rms (−66 dB).

Table 5-17 gives harmonic and intermodulation distortion system specifications when Ampex

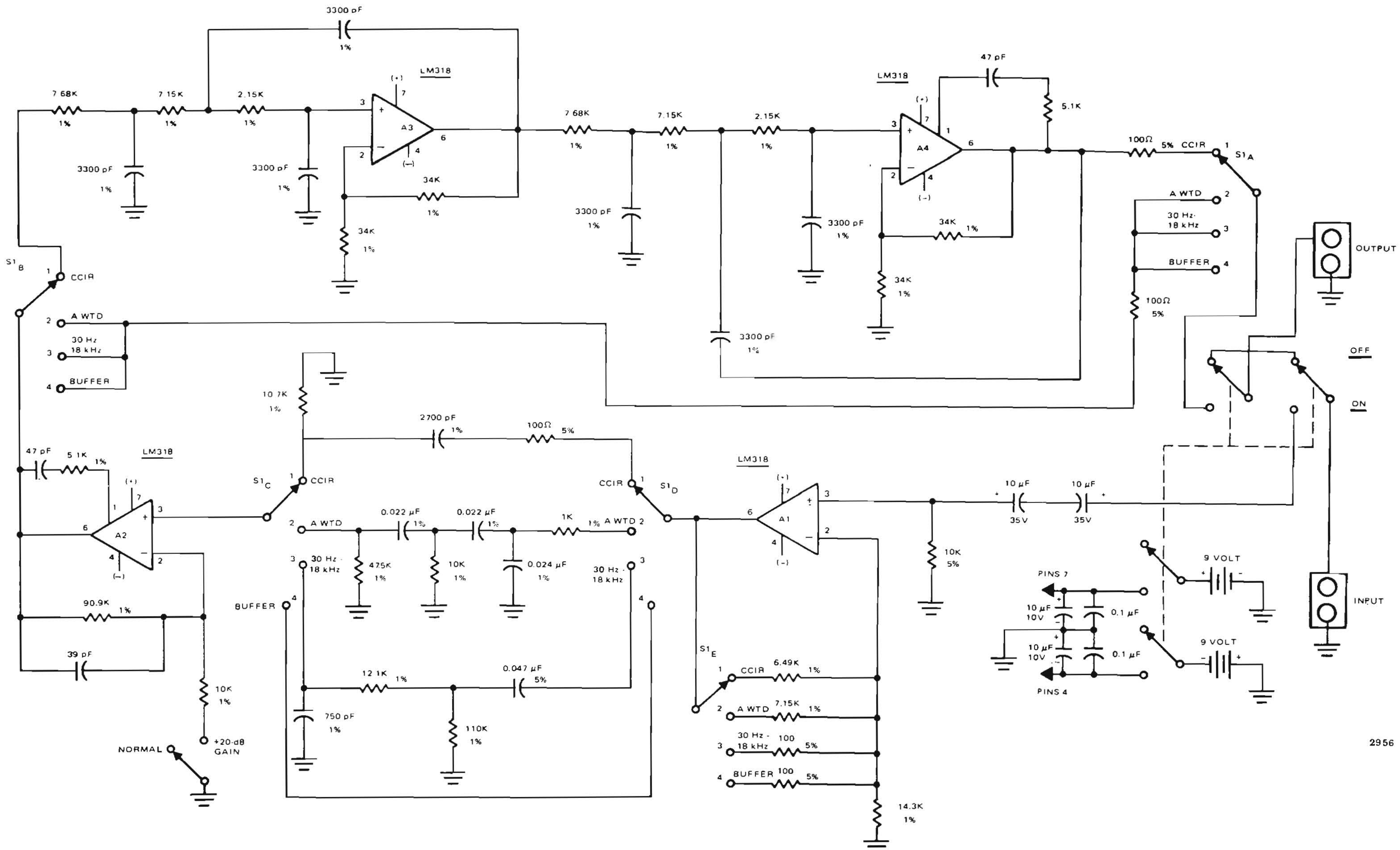



Figure 5-36. Universal Noise Filter Schematic

Table 5-15. Overall Signal-to-Noise Ratio Specifications

| TAPE SPEED AND EQUALIZATION | TRACK FORMAT | 30 Hz – 18 kHz UNWEIGHTED | ANSI "A" WEIGHTED | CCIR REC 468 WEIGHTED |
|---|---|---|---|---|
| 30 in/s AES | Full Track | 77 dB | 81 dB | 73 dB |
| | 2 Track and 4 Track | 72 dB | 76 dB | 67 dB |
| 15 in/s IEC/CCIR | Full Track | 74 dB | 78 dB | 70 dB |
| | 2 Track and 4 Track | 70 dB | 74 dB | 65 dB |
| 15 in/s NAB | Full Track | 73 dB | 77 dB | 69 dB |
| | 2 Track and 4 Track | 69 dB | 73 dB | 63 dB |
| 7.5 in/s NAB | Full Track | 75 dB | 78 dB | 70 dB |
| | 2 Track and 4 Track | 71 dB | 74 dB | 63 dB |
| 7.5 in/s IEC/CCIR | Full Track | 71 dB | 76 dB | 67 dB |
| | 2 Track and 4 Track | 68 dB | 71 dB | 62 dB |
| 3.75 in/s IEC/NAB* | Full Track | 68 dB | 72 dB | 64 dB |
| | 2 Track and 4 Track | 64 dB | 66 dB | 57 dB |

*At 3.75 in/s, overall signal-to-noise ratio is measured with respect to a record level of 740 nWb/m (6 dB above operating level of 370 nWb/m). At 740 nWb/m, mid-frequency, third harmonic distortion is less than 3%.

All signal-to-noise ratio figures given are with respect to a level 9 dB above 370 nWb/m when using Ampex 456 tape or its direct equivalent.

Table 5-16. Typical Standby Signal-to-Noise Ratio Specifications

| TAPE SPEED AND EQUALIZATION | TRACK FORMAT | 30 Hz – 18 kHz UNWEIGHTED | ANSI "A" WEIGHTED | CCIR REC 468 WEIGHTED |
|---|---|---|---|---|
| 30 in/s AES | Full Track | 82 dB | 90 dB | 88 dB |
| | 2 Track and 4 Track | 78 dB | 86 dB | 85 dB |
| 15 in/s IEC/CCIR or NAB | Full Track | 80 dB | 90 dB | 84 dB |
| | 2 Track and 4 Track | 76 dB | 86 dB | 80 dB |
| 7.5 in/s IEC/CCIR or NAB | Full Track | 78 dB | 86 dB | 82 dB |
| | 2 Track and 4 Track | 75 dB | 83 dB | 76 dB |
| 3.75 in/s IEC/NAB* | Full Track | 74 dB | 80 dB | 77 dB |
| | 2 Track and 4 Track | 70 dB | 76 dB | 70 dB |

*At 3.75 in/s, overall signal-to-noise ratio is measured with respect to a record level of 740 nWb/m (6 dB above operating level of 370 nWb/m). At 740 nWb/m, mid-frequency, third harmonic distortion is less than 3%.

All signal-to-noise ratio figures given are with respect to a level 9 dB above 370 nWb/m when using Ampex 456 tape or its direct equivalent.

**Table 5-17. Harmonic and SMPTE Intermodulation System Distortion Specifications**

| | |
|---|---|
| **ELECTRONICS DISTORTION:** | |
| System electronics distortion, including record amplifier, reproduce amplifier and input/output system, at any operating level up to 20 dB above operating level at mid-frequency is <0.03% total harmonic distortion and <0.05% SMPTE intermodulation distortion. | |
| Overall record/reproduce distortion (using Ampex 456 tape or direct equivalent): | At system operating level (0 vu = 370 nWb/m; 6 dB above 185 nWb/m). |
| **Even Order Distortion:** | |
| Even order distortion of a 1-kHz signal recorded at 370 nWb/m is less than 0.1%. | |
| **7.5 in/s – 30 in/s:** | |
| Third Harmonic Distortion at 1 kHz: | <0.3% at recorded flux level of 370 nWb/m (0 vu).<br><3.0% at recorded flux level of 1040 nWb/m (+9 vu). |
| SMPTE Intermodulation Distortion: | <1.0% at recorded flux level of 370 nWb/m (0 vu). |
| **3.75 in/s:** | |
| Third Harmonic Distortion at 500 Hz: | <0.5% at recorded flux level of 370 nWb/m (0 vu).<br><3.0% at recorded flux level of 740 nWb/m (+6 vu). |
| SMPTE Intermodulation Distortion: | <2.0% at recorded flux level of 370 nWb/m (0 vu). |

456 tape or its direct equivalent is used. The harmonic distortion measurement should only be performed if the reproduce, record, and bias adjustments have been correctly made or are known to be correct. Proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.

2. If an input/output assembly is being used, connect a spectrum analyzer or wave analyzer to appropriate output connector, and connect an audio oscillator to appropriate input connector (Figures 2-14 and 2-15).

3. If an input/output assembly is not being used, connect a spectrum analyzer or wave analyzer to appropriate recorder/reproducer output connector J13 or J14, and connect an audio oscillator with a source impedance of not greater than 200 ohms to appropriate input connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

4. Apply power and thread a reel of tape on the transport and place system into thread mode.

5. Set speed switch to tape speed selected for measurement.

6. Place system into record mode.

7. Set oscillator frequency to 1 kHz (500 Hz at 3.75 in/s only) and adjust oscillator output level for –5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

8. Adjust wave analyzer to measure second harmonic content; this should not exceed –60 dB with respect to the level of the fundamental set in step 7.

9. Adjust wave analyzer to measure third harmonic content. The harmonic content should not exceed levels given in Table 5-17 relative to the level of the fundamental set in step 7.

10. Increase oscillator output level to system peak operating level. This is +4 dBm at the output of the recorder/reproducer or +13 dBm at the output of the input/output assembly.

11. Adjust wave analyzer to measure third harmonic content. The harmonic content should not exceed levels given in Table 5-17 relative to the level of the fundamental set in step 10.

12. Repeat entire procedure for each channel.

**5-83. SMPTE Intermodulation Distortion**

Intermodulation distortion is produced by nonlinearity in the record/reproduce process which produces frequencies in the output signal equal to the sums and differences of integral multiples of the component frequencies present in the input signal (harmonics not included). Measurement of intermodulation distortion is a convenient method of obtaining a qualitive indication of system performance. However, a reading in excess of specifications gives no indication of the possible cause, as a poor or damaged tape may produce amplitude fluctuations in a high-frequency carrier which greatly exceed the true intermodulation products. Therefore a judgment is required when attempting to interpret the measurements.

Table 5-17 gives harmonic and intermodulation distortion system specifications when Ampex 456 tape or its direct equivalent is used. The measurement should only be performed if the reproduce, record, and bias adjustments have been performed or are known to be correct. To measure intermodulation distortion as defined by the SMPTE, proceed as follows:

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7.

2. If an input/output assembly is being used, connect intermodulation analyzer test signal output to appropriate input connector (Figures 2-14 and 2-15), and connect appropriate output connector of input/output assembly to input of intermodulation analyzer.

3. If an input/output assembly is not being used, connect intermodulation analyzer test signal output to appropriate recorder/reproducer connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3), and connect appropriate output connector J13 or J14 to input of intermodulation analyzer.

4. Apply power and thread a reel of bulk-erased tape on the transport and place system into thread mode.

5. Set speed switch to tape speed selected for measurement.

6. Place system into record mode.

7. Adjust intermodulation analyzer composite signal output amplitude for −5 dBm at the output of the recorder/reproducer, or +4 dBm at the output of the input/output assembly.

8. Adjust intermodulation analyzer to normalize the input signal, and then read intermodulation distortion. Compare readings with specifications given in Table 5-17 for tape speed and equalization standard in use.

9. If type of intermodulation analyzer permits, verify tape condition and validity of measurement in step 8 as follows:

   Remove or switch off the low-frequency test signal. Intermodulation distortion reading should drop at least to 40% of reading obtained in step 8. If the reading did not drop, this is an indication that the tape is mechanically damaged or dirty, or that some element in the tape path is causing excessive amplitude fluctuation of the high-frequency test signal.

**5-84. Flutter**

Flutter is measured by recording and reproducing a constant frequency tone. Any non-uniform

motion in the recorder/reproducer mechanism frequency modulates the tone. This modulation, called flutter, is measured with an fm demodulator within a flutter meter. The ATR-100 flutter specifications are measured according to standards specified by DIN 45 507 and ANSI S4.3 peak weighted and unweighted. The rms flutter is measured as specified by the NAB standard.

When performing measurements, it is possible for the record mode flutter to add or subtract from the reproduce mode flutter, depending upon the phase relationship of the recorded and reproduced signals; therefore, it is necessary to play the tape several times and average the flutter meter readings.

Prior to making a flutter measurement, perform the following steps.

1. Clean and demagnetize the heads and other tape path components as described in the *Preventive Maintenance* portion of this section of the manual, paragraphs 5-4 and 5-7. (Note: Flutter meters are sensitive to amplitude modulation that results from poor head-to-tape contact or from signal dropouts.)

2. Check tape tension and adjust, if necessary, as described under *Tape Tension* adjustments, paragraph 5-66.

3. The audio channel to be used for flutter measurement should be in correct alignment. If necessary, perform the *Audio Signal System Alignment* procedure (paragraph 5-30).

4. Use good quality bulk erase tape (Ampex 456 or equivalent). Use a typical reel size for tape speed in use; i.e., NAB type A reel for 30-in/s operation.

The following procedure applies to the use of a Micom (Bahrs) Model 8100-W flutter meter. If a different flutter meter is used, the manufacturer's instructions should be followed.

To measure flutter, proceed as follows:

1. If an input/output assembly is being used, connect the test oscillator output of the flutter meter to the input connector of the channel selected for test, and connect signal input connector of flutter meter to appropriate output connector (Figures 2-14 and 2-15).

2. If an input/output assembly is not being used, connect the test oscillator output of the flutter meter to recorder/reproducer input connector J13 or J14 corresponding to the channel selected for test, and connect signal input connector of flutter meter to appropriate output connector J13 or J14 (Figure 2-13 and Tables 2-2 and 2-3).

3. Apply power, thread a reel of bulk-erased tape on transport, and place system into thread mode.

4. Select input monitoring for channel being used. Adjust recorder/reproducer output level and/or flutter meter input level for required flutter meter input level.

5. While in input mode (tape not moving), measure static signal flutter and verify that flutter is way below level of flutter anticipated (Table 1-4). Typical levels are below 0.005% peak weighted or 0.01% unweighted.

6. Set flutter meter to measure peak weighted and meter scale to read 0.1% full scale.

7. Select repro monitoring mode for channel being used, place system into record mode, and record for approximately one minute. While recording, note flutter indication on flutter meter.

8. Rewind tape to the beginning of the recording, place system into play mode, and read indication on flutter meter. Repeat this step three times and average the four readings along with the reading obtained while recording (step 7). The average reading should meet the flutter specifications given in Table 1-4.

## 5-85. CORRECTIVE MAINTENANCE

When a failure is noted, perform the appropriate head maintenance, troubleshooting, or component replacement procedure.

CAUTION

**TO PREVENT POSSIBLE DAMAGE TO ELECTRICAL COMPONENTS, ALWAYS TURN RECORDER/REPRODUCER POWER OFF BEFORE REMOVING OR INSTALLING A HEAD ASSEMBLY, OR BEFORE REMOVING OR INSTALLING A PRINTED WIRING ASSEMBLY (PWA) INTO THE RECORDER/REPRODUCER OR INPUT/OUTPUT ASSEMBLY.**

### 5-86. Head Maintenance

Head cleaning, demagnetizing, and cleaning and lubrication of the scrape flutter idler was covered under *Preventive Maintenance*, paragraph 5-3, and adjustment of head azimuth was covered under *Alignment and Adjustments*, paragraph 5-29. Use the following instructions to change the entire head assembly or to change an individual head stack on the head assembly.

**5-87. Changing Head Assembly.** To remove head assembly, proceed as follows:

1. Remove power from ATR-100.
2. Remove head cover assembly (Figure 5-23) from transport by carefully lifting cover straight up.
3. Insert Allen wrench through center hole in head shield (Figure 5-37) and turn spring-loaded screw 1/4 turn clockwise to release head assembly.
4. Carefully lift head assembly straight up from the transport.

To install head assembly, proceed as follows:

1. Carefully lower head assembly over transport to mate the head-centering pins (Figure 5-38) on the transport into the bottom of the head assembly. Lower head assembly onto transport and fully mate the head connector.

NOTE

**For removal or installation of head assembly, the spring-loaded screw is always turned 1/4 turn clockwise.**

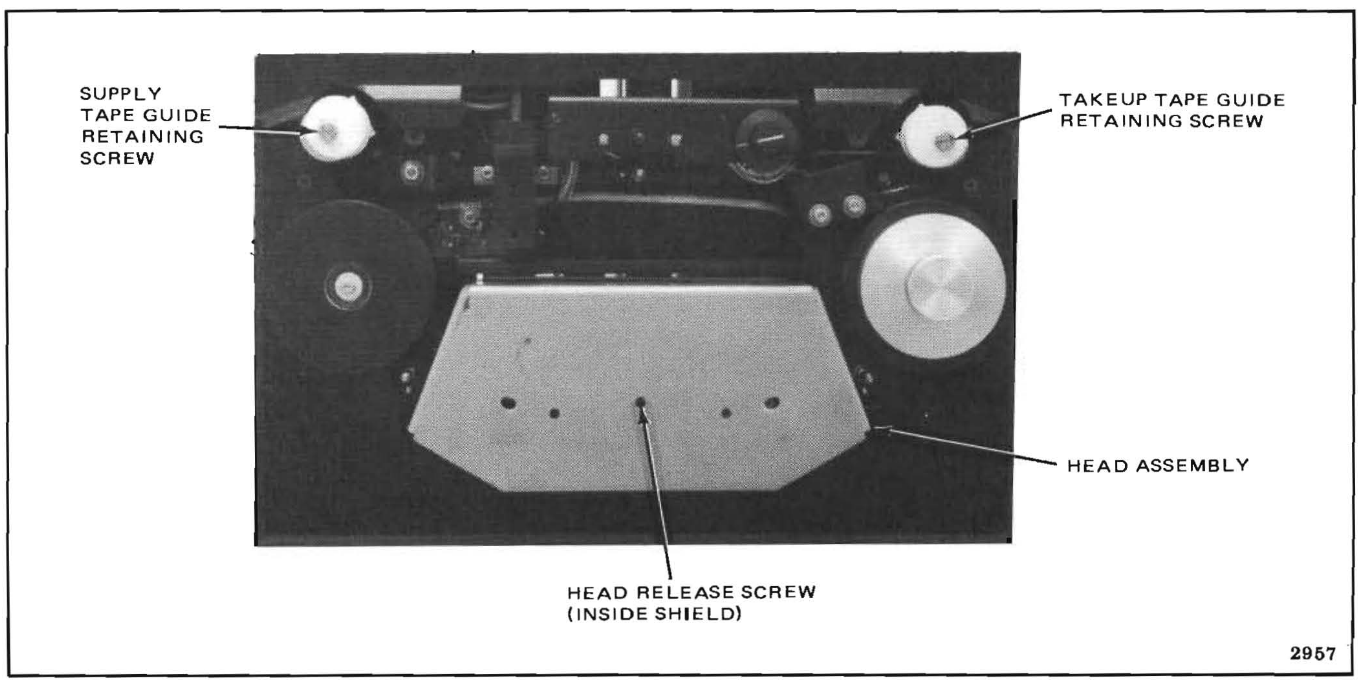



**Figure 5-37. Head Assembly and Tape Guides**

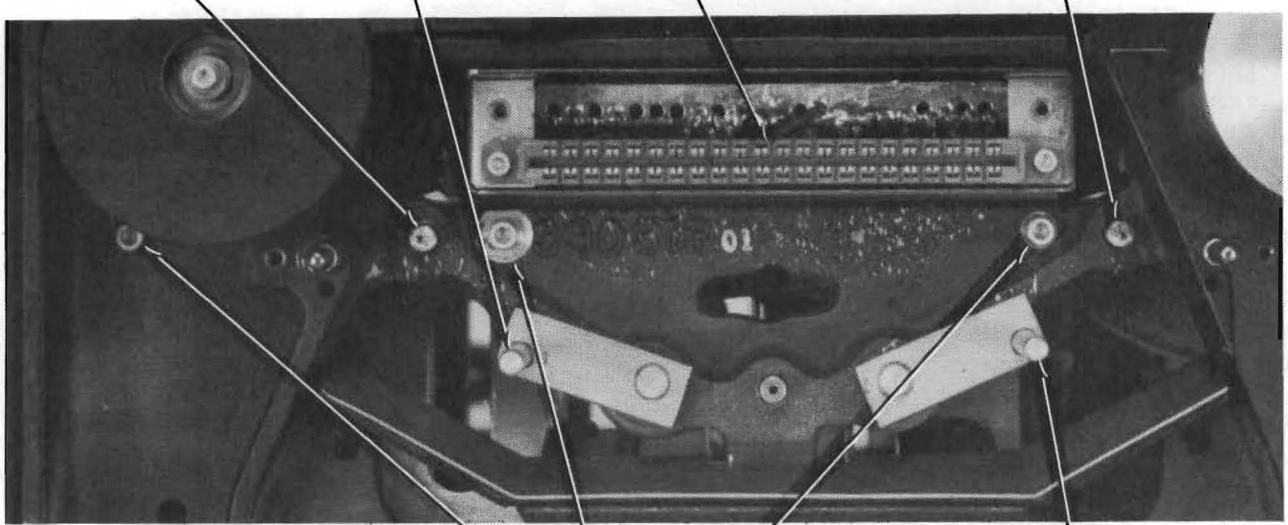



**Figure 5-38. Top View of Transport with Head Assembly Removed**

2. Lock the head assembly to the transport by inserting an Allen wrench through hole in head shield, and turn spring-loaded screw 1/4 turn clockwise to lock head to transport.

**5-88. Changing Head Stacks.** To change a record, reproduce, or erase head stack, proceed as follows:

1. Remove power from ATR-100.
2. Remove the entire head assembly from the transport as follows:
   a. Remove head cover assembly (Figure 5-23) from transport by carefully lifting cover straight up.
   b. Insert Allen wrench through center hole in head shield (Figure 3-37) and turn spring-loaded screw 1/4 turn clockwise to release head assembly.
   c. Carefully lift head assembly straight up from transport.
3. Remove the main head shield from the head assembly by removing four screws (Figure 1-3) that secure the main head shield to the base plate.
4. Carefully unplug the head-stack connector(s) of the head stack to be changed (Figure 5-39).
5. Remove head-stack mounting screw and spring (Figure 5-39).
6. Remove stack by pressing the spring-loaded pin (Figure 5-40), from underside of head base plate, and carefully sliding stack toward head connector PWA. When removing the reproduce head stack, rotate the stack on the pin to clear the head connector PWA.

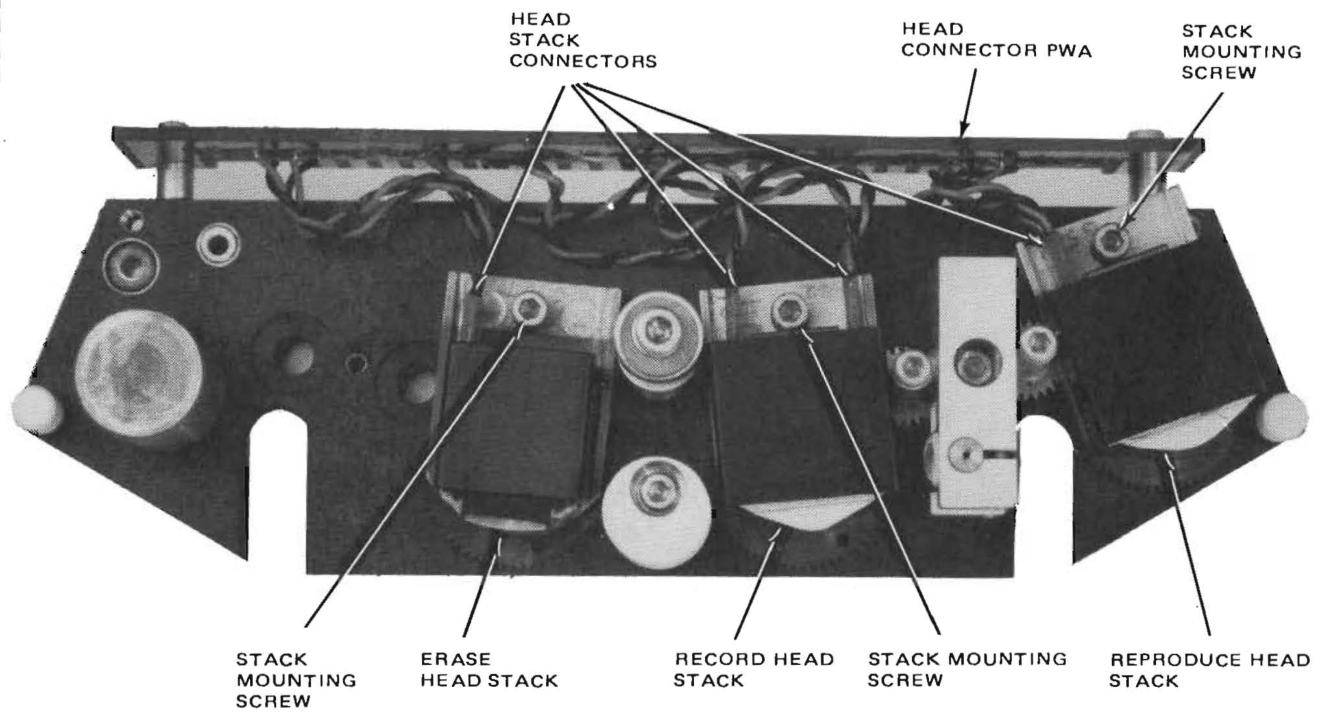



**Figure 5-39. Top View of Head Assembly with Main Head Shield Removed**

7. Install new stack by pressing spring-loaded pin and sliding new stack forward into place on the tapered gear.

8. Reinstall head-stack mounting screw and spring. Lightly tighten screw to fully compress spring, then turn screw one full turn counterclockwise to permit head azimuth to be adjusted.

9. Carefully reinstall head-stack connector(s).

10. Reinstall main head shield using four screws removed in step 3.

11. Install entire head assembly onto transport as follows:

    a. Carefully lower head assembly over transport to mate the head centering pins (Figure 5-38) on the transport into the bottom of the head assembly. Lower head assembly onto transport and fully mate the head connector.

    b. Lock the head assembly to the transport by inserting an Allen head wrench through hole in head shield and turn spring-loaded screw 1/4 turn clockwise to lock head to transport. (Note: For removal or installation of head assembly, the spring-loaded screw is always turned 1/4 turn clockwise.)

12. Perform the appropriate record, reproduce, or erase alignment procedure given in this section of the manual under the heading *Audio Signal System Alignment*, paragraph 5-30. No azimuth adjustment is required for the erase head stack.

### 5-89. Troubleshooting

Use standard troubleshooting techniques to isolate a fault as mechanical or electrical in origin. Then proceed to isolate the fault to a certain stage or component. As an aid in locating faults, dc voltages and reference frequencies are given at many

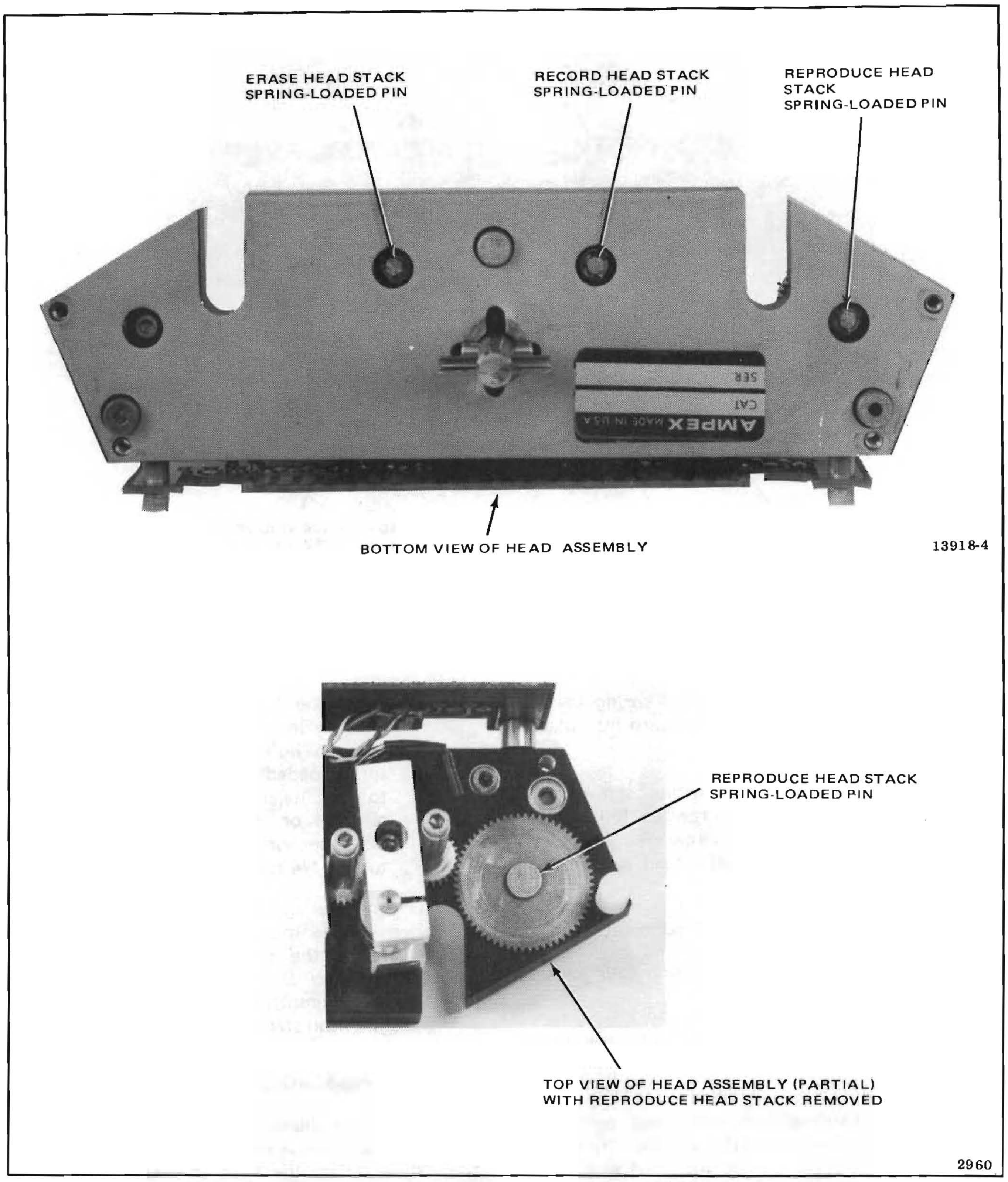



**Figure 5-40. Head Assembly Spring Loaded Pin Locations, Main Head Shield Removed**

points on the schematic diagrams (Section 6), and in the theory section (Section 4) and associated block diagrams.

The performance tests (paragraph 5-76) can be used as an aid in diagnosing a fault. These procedures include tests for checking tape tension, absolute tape speed accuracy, speed variation, operating level, signal-to-noise ratio, harmonic distortion, intermodulation distortion, and flutter. In addition, troubleshooting hint tables and troubleshooting flow diagrams are provided in this section (paragraph 5-93). Any of the corrective actions listed in the Table of Contents for Section 5 may be required. Recommended test equipment that may be required is listed in Table 5-1.

**5-90. Extender Boards.** Alignment and troubleshooting procedures are greatly simplified by using the electronics assembly extender board (supplied with the recorder/reproducer) and the input/output assembly extender board (accessory). These boards are listed in Table 5-1. The extender board, when installed between the circuit board and its receptacle, moves the circuit board outside the chassis so all components are accessible for testing or adjustment.

### CAUTION

**DO NOT REMOVE OR INSERT A CIRCUIT BOARD (PWA) WITH POWER ON. TO DO SO MAY CAUSE DAMAGE TO CIRCUIT COMPONENTS. ALSO, USE EXTREME CARE NOT TO INSERT A PWA ON AN EXTENDER BOARD INTO A WRONG SLOT IN THE ELECTRONICS ASSEMBLY. THE EXTENDER BOARD IS NOT KEYED LIKE THE PWA's.**

**5-91. Power Transistor Locations.** Figure 5-41 shows the locations, by schematic symbol reference on schematic diagram no. 4840423, of the various power supply, solenoid driver, and MDA

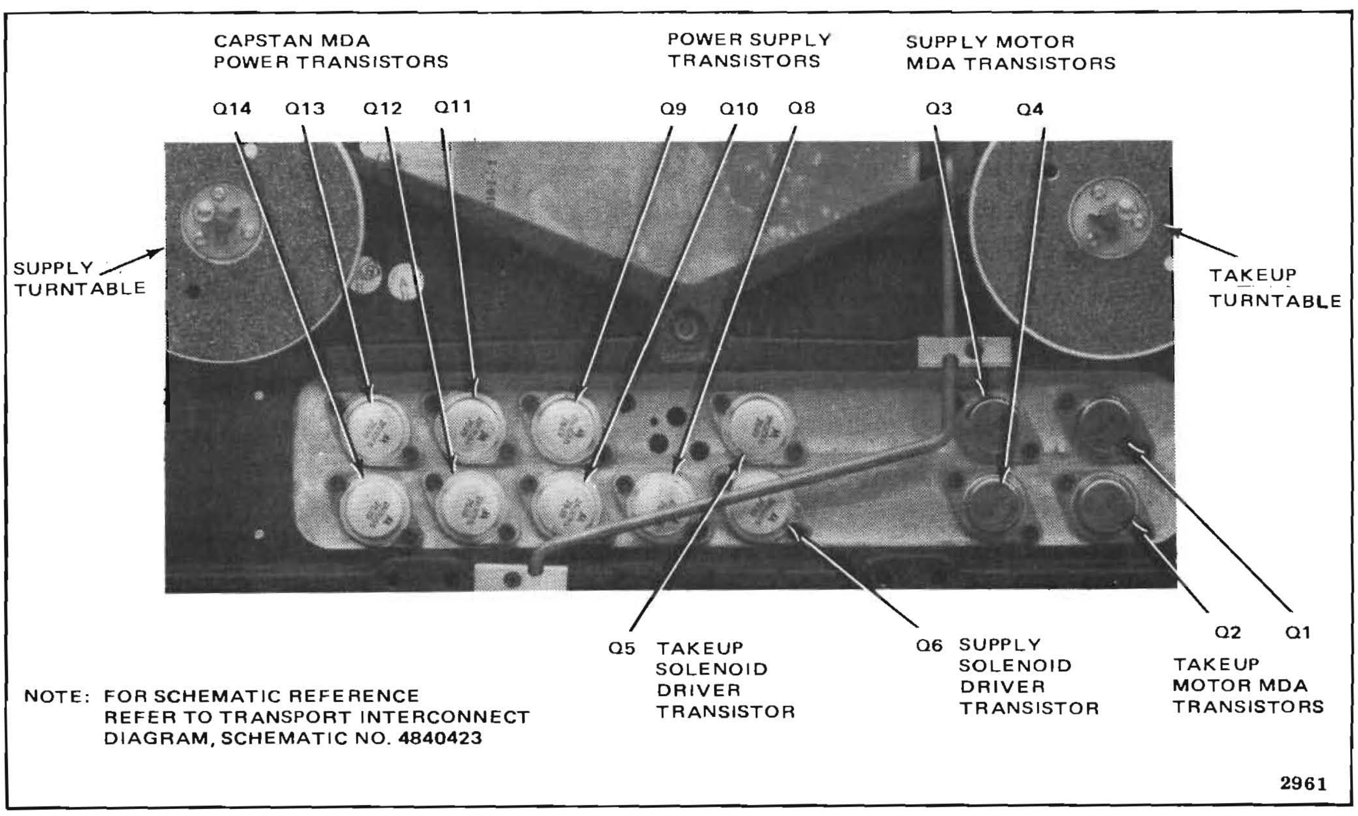



**Figure 5-41. Power Transistor Locations on Heat Sink**

power transistors located on the top surface of the transport heat sink.

**5-92. Flutter.** The vibration analyzer portion of the flutter meter can be used to help isolate flutter to a certain frequency. Table 5-18 shows normal frequencies generated by the rotating mechanical components for each of the four tape speeds. This table is most useful for flutter evaluation when the weighted flutter measurement is out of specification. Troubleshooting hints for flutter problems are given in Table 5- 21.

**5-93. Troubleshooting Hints.** Troubleshooting hints for problems associated with the tape transport and tape timer are given in Tables 5-19 and 5-20. respectively. Troubleshooting hints pertaining to flutter, excessive noise or poor signal-to-noise ratio, harmonic and intermodulation distortion, and general problems are given in Tables 5-21 through 5-24, respectively. Troubleshooting flow charts pertaining to the audio system are given in Figures 5-42 through 5-45.

**Table 5-18. Rotational Rates (Hertz)**

| COMPONENT | TAPE SPEED | | | |
|---|---|---|---|---|
| | 3.75 IN/S | 7.5 IN/S | 15 IN/S | 30 IN/S |
| Capstan | 0.50 | 1.00 | 2.00 | 4.00 |
| Tape Timer | 0.50 | 1.00 | 2.00 | 4.00 |
| Capstan Second Harmonic | 1.00 | 2.00 | 4.00 | 8.00 |
| Takeup Tape Guide | 1.43 | 2.86 | 5.72 | 11.45 |
| Supply Tape Guide | 1.47 | 2.93 | 5.87 | 11.73 |
| Capstan Third Harmonic | 1.50 | 3.00 | 6.00 | 12.00 |
| Takeup Guide Second Harmonic | 2.86 | 5.72 | 11.45 | 22.90 |
| Supply Guide Second Harmonic | 2.93 | 5.87 | 11.73 | 23.46 |
| Tape Timer Mass Resonance | 59 Hz for 1/2-inch tape width<br>44 Hz for 1/4-inch tape width | | Independent of tape speed but slightly dependent on tape type and reel pack. | |

**Table 5-19. Troubleshooting Hints – Tape Transport**

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Power will not switch on | Power actuator bar not actuating main power switch (Figure 2-11).<br>No main power from power source.<br>Main power fuse blown. |
| Power will not switch off | Power actuator bar not actuating main power switch. |
| Transport will not enter thread mode | Supply or takeup tension arm microswitch not actuating.<br>Relay K1 in power supply not operating. Capstan Servo PWA not plugged into electronics assembly. |

Table 5-19. Troubleshooting Hints — Tape Transport (Continued)

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Transport will not enter thread mode (continued) | Supply or takeup LED PWA harness wires binding against rear overlay panel.<br>Tension arm torque.<br>Reel servo malfunction.<br>Stop pushbutton switch.<br>Thread control logic circuitry on PWA No. 7.<br>Reel Servo PWA No. 9 not plugged into electronics assembly. |
| Transport will not unthread | EDIT pushbutton switch or associated circuitry.<br>Capstan still rotating when EDIT pushbutton switch pressed.<br>Motion sense circuit malfunction on PWA No. 8. |
| Tape slips on tape timer during acceleration | Tape tension too low.<br>Tape tension unbalanced.<br>Tape logic direction command wrong because of capstan tach sensor misadjustment. |
| Tape slips on capstan in forward or reverse direction | Tape tension too low.<br>Tape tension greatly unbalanced.<br>Tape too wide and being pinched by tension arm roller tape guides.<br>Tape logic direction command unstable because of capstan tach sensor misadjustment or insufficient level. |
| Transport will not enter play edit mode | Tension arm idler not contacting capstan.<br>Play edit control logic on PWA No. 7.<br>Mode locked out on PWA No. 7. |
| Transport will not come out of play edit mode | Tape peeler misadjusted too far back allowing tension-arm guide to toggle over center of capstan.<br>Capstan still rotating when EDIT pushbutton switch is pressed.<br>Motion sense circuit malfunction on PWA No. 8. |
| Transport will enter thread mode but no tape motion in mode | Capstan motor power connection.<br>Capstan MDA malfunction. |
| Tape motion possible in fast forward, rewind and spool modes but not play or record modes | Lockout circuitry activated because inactive recorder/reproducer speed selected. |
| Tape lifter arms will not fully retract or operate in fast modes | Tape lifter arm shaft binding in pivot bushings. |

Table 5-19. Troubleshooting Hints – Tape Transport (Continued)

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Tape lifter arms will not fully retract or operate in fast modes (continued) | O-ring seal inside tape lifter solenoid hanging up in solenoid.<br>Tape lifter solenoid shield not properly adjusted.<br>Tape lifter solenoid driver (Q23, Q22) on PWA No. 9 is defective. |
| Tape lifter arms out too far or not far enough in fast tape modes | Individual tape lifter arm position not correct. |
| Tape lifter operates too slow or too fast | Solenoid air-leak control needs adjusting.<br>O-ring seal in solenoid damaged or binding. |
| Capstan will not stop rotating | Capstan tach sensor misadjusted.<br>Capstan tach sensor gain misadjusted.<br>Tape tension unbalanced. |
| Capstan runs fast in one direction continuously | Voltage regulator on PWA No. 8 has failed. |
| In stop mode, capstan creeps in either direction | Tape tension unbalanced. |
| Capstan will not phase lock | Tape tension incorrect.<br>Tach signal is noisy.<br>Tach gain set too high or too low. |
| Transport will not enter stop/edit (unthread) mode when a tension arm is moved to an inner or outer limit | Position of tension arm LED PWA incorrect.<br>LED, on PWA, light output is too low. |
| Poor tape pack in 180-in/s spool mode in either direction | Tape tension too low.<br>Poorly slit tape.<br>Use of non back-coated tape.<br>Tape needs to be re-conditioned by operating in spool mode several times.<br>Reel drive motor shaft damaged and not perpendicular to tape path.<br>Type of tape used will not pack well at 180 in/s; try 60 in/s. |
| Poor tape pack in fast wind modes | Normal as air becomes entrapped between layers of tape. Use more accurately slit tape. Use spool modes for packing. |
| Tape pack height within reel incorrect (metal precision reels or plastic reels) | Turntable height wrong.<br>Tape tension arm guide height wrong or arm shaft is bent. |

Table 5-19. Troubleshooting Hints – Tape Transport (Continued)

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Tape pack height within reel incorrect (metal precision reels or plastic reels) (continued) | Reel motor axis not perpendicular with tape path – dirt particles under motor mounting.<br>Axis of tape guide nearest reel in question not perpendicular to tape path.<br>Poorly slit or damaged tape; try another tape. |
| Poor takeup tape pack in play and record modes | Very poorly slit tape.<br>Axis of takeup reel motor shaft not perpendicular to tape path.<br>Takeup tension arm roller not perpendicular to tape path. |

Table 5-20. Troubleshooting Hints – Tape Timer

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Timer display accuracy incorrect in all modes | Check transport direction control logic.<br>Check crystal reference frequency.<br>Check timer tachometer signal. |
| Timer accuracy incorrect only at high tape speeds | Capstan tach signal level incorrect.<br>Capstan tach sensor incorrectly adjusted.<br>Tape tension too low. |
| Timer will not reset to zero | Timer reset switch.<br>Timer reset logic. |

Table 5-21. Troubleshooting Hints – Flutter

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Weighted flutter at 15 or 30 in/s out of specification | Low-frequency flutter excessive due to capstan tachometer, supply tension arm tape guide, or takeup tension arm tape guide (see Rotational Rates (Hertz), Table 5-16).<br>Poor surface quality of tape used.<br>Tape not bulk erased. |
| Unweighted flutter at 3.75 or 7.5 in/s out of specification | Tape tension balance incorrect.<br>Capstan tachometer dirty.<br>Poor surface quality of tape used. |

Table 5-21. Troubleshooting Hints – Flutter (Continued)

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Unweighted flutter at 3.75 or 7.5 in/s out of specification (continued) | Tape not bulk erased.<br>Tape guide rollers not cleaned.<br>Audio signal system alignment not correct.<br>Capstan tachometer signals not set to proper phase; levels too high or too low.<br>Capstan motor dragging or bearings defective.<br>Capstan motor commutator dirty or damaged. |
| Excessive scrape flutter (high-frequency flutter) | Dirty or dry scrape flutter idler bearings; clean and lubricate.<br>Tape surface quality poor causing uncontrollable scrape flutter.<br>Scrape flutter idler position incorrect against tape.<br>Scrape flutter idler not perpendicular to tape path causing tape to slide on roller. |

Table 5-22. Troubleshooting Hints – Signal-to-Noise Ratio

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| Excessive system noise or signal-to-noise ratio is out of specifications | Incorrect operating level is being used.<br>Incorrect noise weighting filter being used for the particular specification being measured.<br>Tape that was used for recordings of a different track format not bulk erased.<br>Check erase depth adjustment.<br>Heads and guides not clean or demagnetized.<br>Check second harmonic distortion. If high, it could indicate magnetized component in tape path which may possibly be defective and cause high noise.<br>Check that grounding straps are secure.<br>Check external test equipment for ground loops.<br>If noise is cyclic over a long period, check for noisy main voltage regulator A8 on Main Audio PWA. |

Table 5-23. Troubleshooting Hints – Harmonic and Intermodulation Distortion

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| High second harmonic distortion | Heads and/or tape guides magnetized. |
| | Audio oscillator used for measurement has a second harmonic component greater than 0.03% rms (–70 dB) for fundamental frequencies from 500 Hz to 1.0 kHz. |
| | DC offset voltage incorrectly set in input/output assembly input amplifier. |
| | System output connected to highly nonlinear load, such as overdriven level meters. |
| | Record amplifier malfunctioning. |
| | Record head in presence of large dc field. |
| | Erase circuitry malfunctioning. |
| High third harmonic distortion | Audio oscillator used for measurement has a third harmonic component greater than 0.05% rms (–66 dB). |
| | Record and/or reproduce operating levels not set correctly for type of tape in use. |
| | Bias not set correctly (2.75 dB ±0.5 dB overbias at 1.5-mil wavelength using Ampex 456 tape). |
| | DC offset voltage incorrectly set in input/output assembly line output amplifier. |
| High intermodulation distortion | Same causes as for high second or third harmonic distortion. |
| | Physically damaged tape causing excessive amplitude fluctuation of high frequency carrier. |

Table 5-24. Troubleshooting Hints – General

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| All LED's illuminated on control unit and transport inoperative | Master oscillator inoperative. |
| LED's on control unit will not illuminate | 5-Vdc supply inoperative – check fuse F2 (Figure 2-11). |
| | Control unit connector P11 disconnected. |
| Control unit audio status indicators do not match actual system status | System lockout circuit operating as invalid speed has been selected. |
| | Multiplex circuitry. |
| When input/output assembly is connected, system monitors input signal at all times | System lockout circuit operating as invalid speed has been selected. |

Table 5-24. Troubleshooting Hints – General (Continued)

| PROBLEM | POSSIBLE CAUSE/CHECK |
|---|---|
| BIAS and/or ERASE indicators on input/output assembly illuminate when system not in record mode | Logic circuitry on Audio PWA or Audio Control PWA.<br>±15-Vdc supply on input/output assembly out of tolerance. |
| Transport will not stop or change transport modes when in record mode | ERS logic command failure – Audio Control PWA.<br>MRB logic command not unlatching – Transport Control PWA. |

## 5-94. Component Replacement Procedures

The following paragraphs contain removal instructions for the components listed below:

Power Supply

Electronics Assembly

Capstan/Tach Assembly

Reel Drive Motors and Brushes

**5-95. Power Supply.** Access to the interior of the power supply is obtained by loosening the four power-supply cover screws (Figure 5-46) and removing the cover. To remove and replace the entire power supply, proceed as follows:

1. If recorder/reproducer is located in a cabinet, remove entire bottom cover of cabinet (ten screws).
2. Disconnect fan connector P20.
3. Remove transport rear overlay panel (six screws shown in Figure 2-2).
4. If a ground strap is connected to the power supply, remove the ground strap on the power supply.
5. Disconnect power supply connectors P1 and P2 (Figure 5-46).

WARNING

THE POWER SUPPLY IS HEAVY AND TWO PEOPLE ARE USUALLY REQUIRED TO SAFELY REMOVE THE SUPPLY FROM THE TRANSPORT.

6. Support the weight of the power supply while removing the three hex-socket power supply mounting screws (Figure 5-46) that secure the power supply to the rear of the transport casting.
7. Reinstall power supply in the reverse order of removal while being careful not to damage any transport harness wires located in the power supply area.

**5-96. Electronics Assembly.** To remove and replace the electronics assembly, proceed as follows:

1. If recorder/reproducer is in a cabinet, remove entire bottom cover of cabinet (ten screws).
2. Disconnect fan connector P20.
3. Remove head cover assembly, head assembly, and front overlay panel (two screws) shown in Figure 5-23.
4. Remove ground strap that connects to electronics assembly from the tape transport. On early production units, strap is located front left of transport. On later units, strap is located in the rear of the head connector area.
5. Disconnect electronics assembly harness connector P16 that connects to tach sensor connector J16.

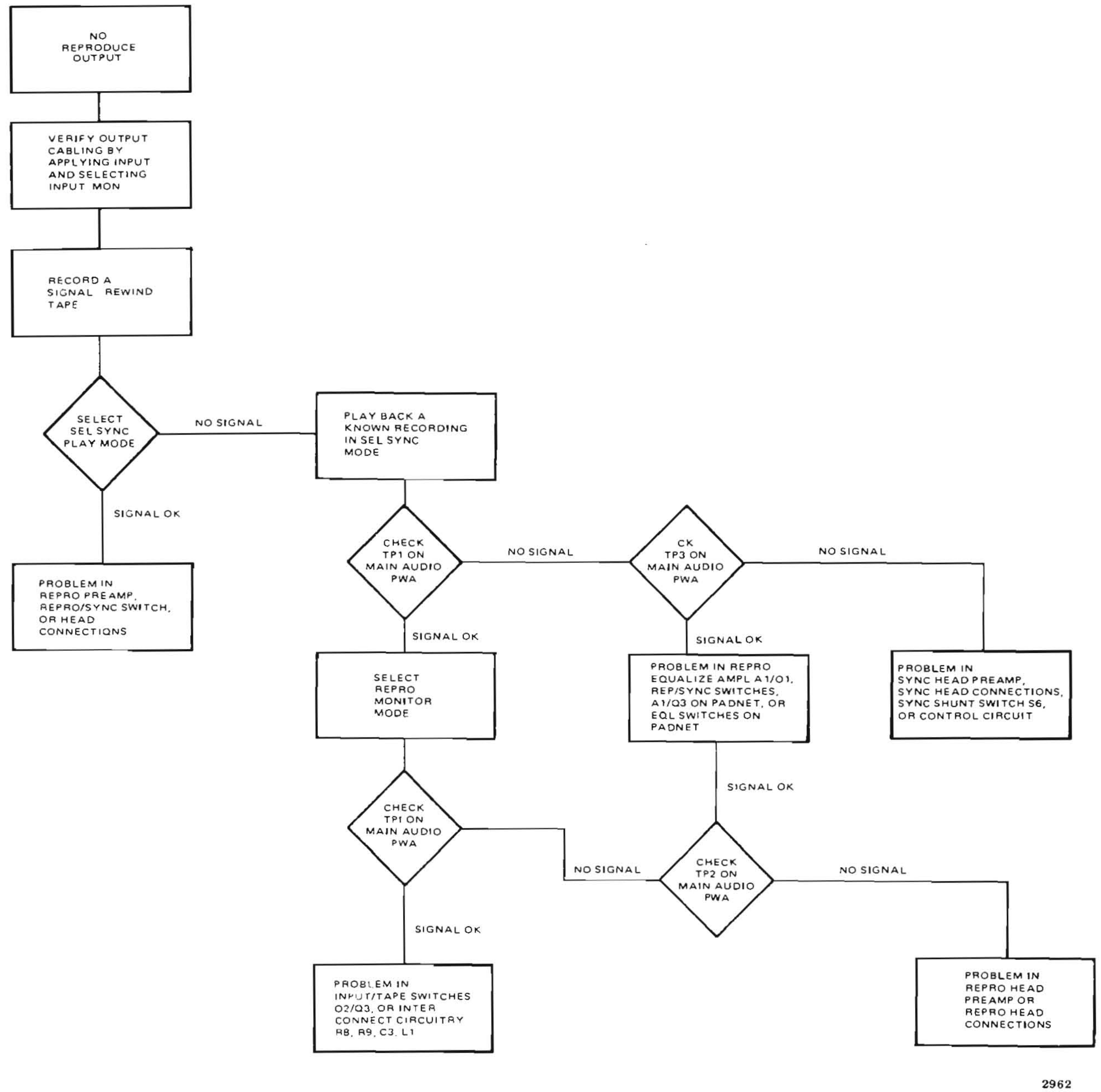



Figure 5-42. No Reproduce Output – Troubleshooting Flow Chart

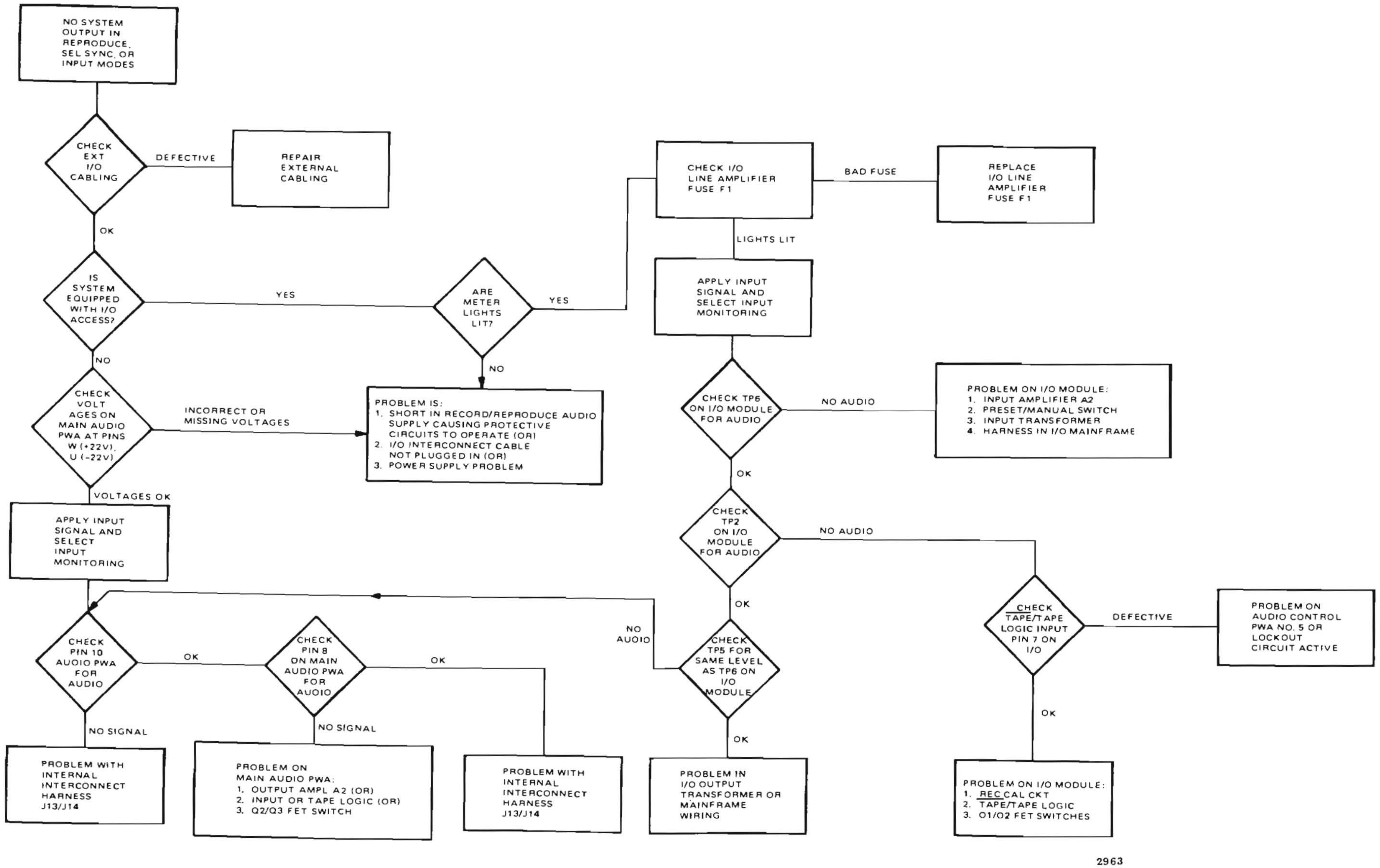



**Figure 5-43. No System Output in Reproduce, Sel Sync, or Input Modes — Troubleshooting Flow Chart**

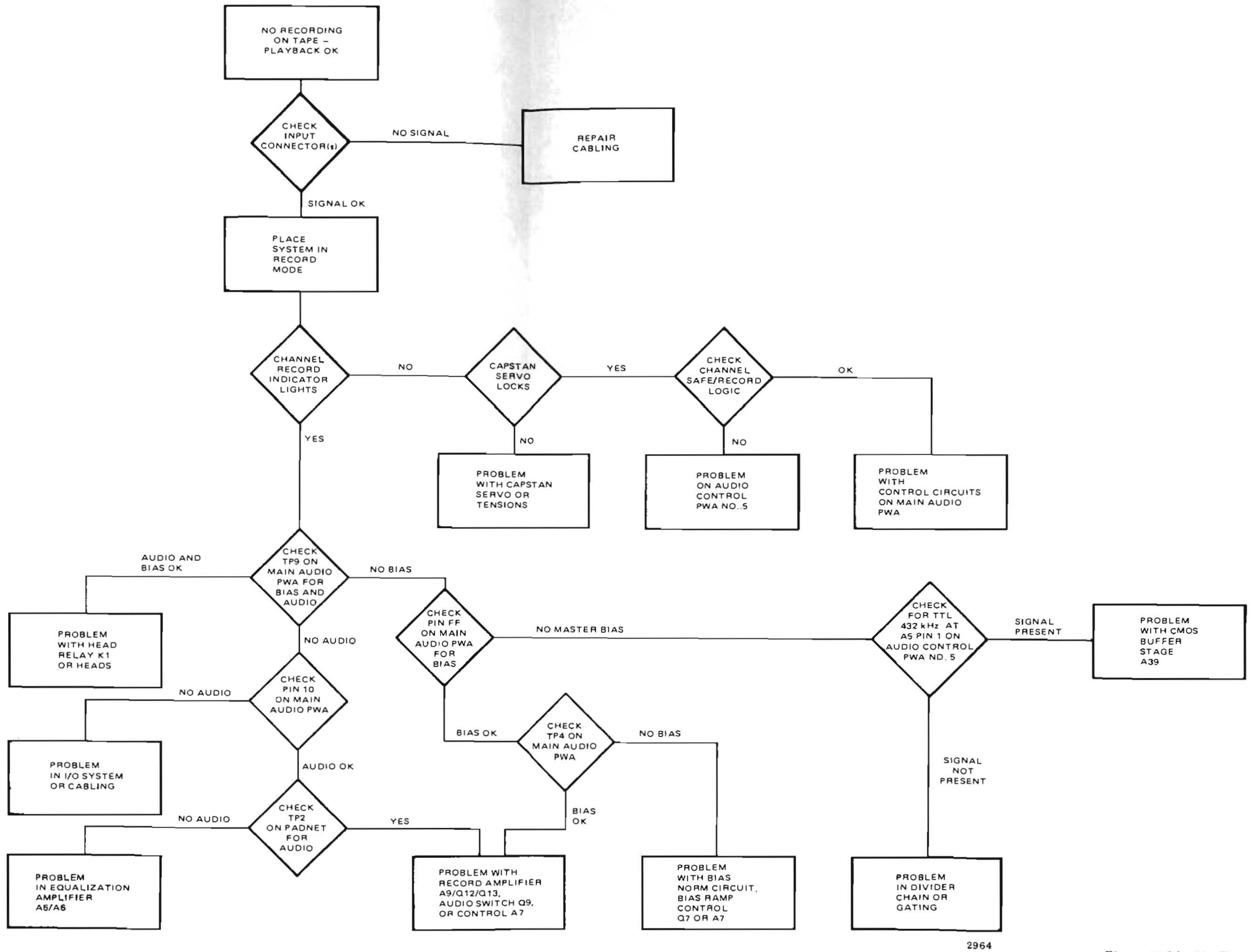



Figure 5-44. No Recording on Tape – Troubleshooting Flow Chart

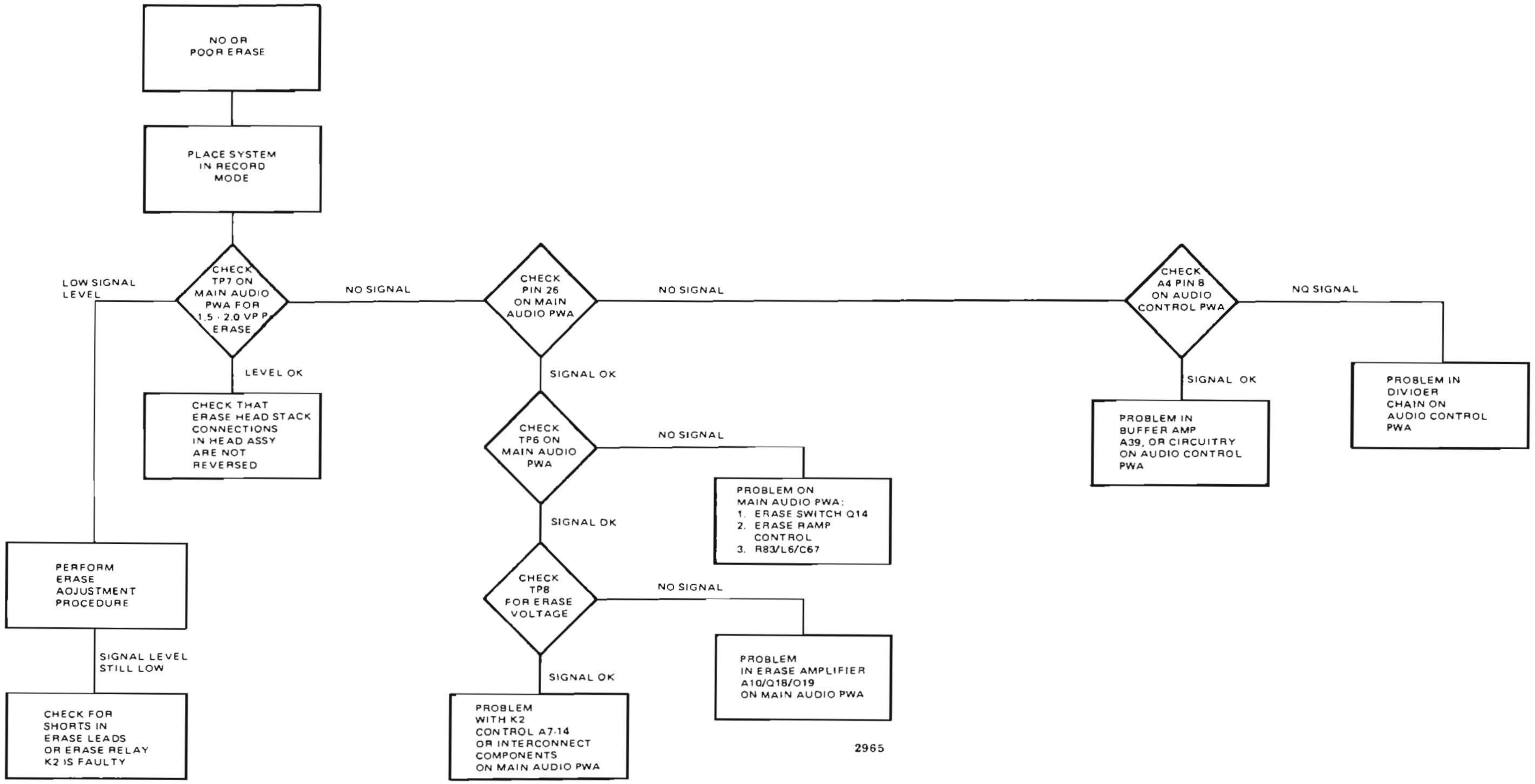
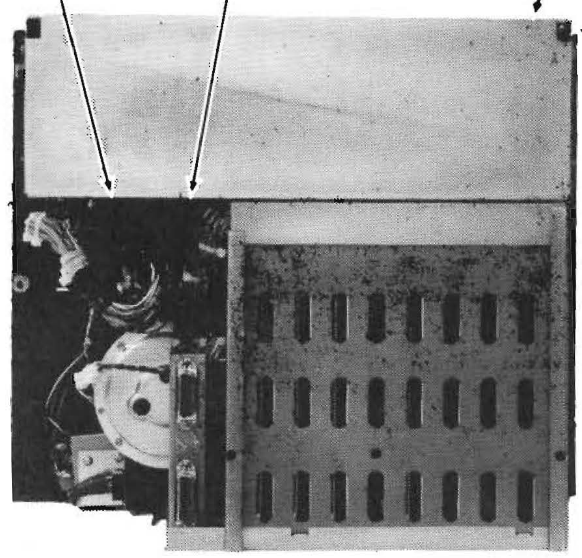
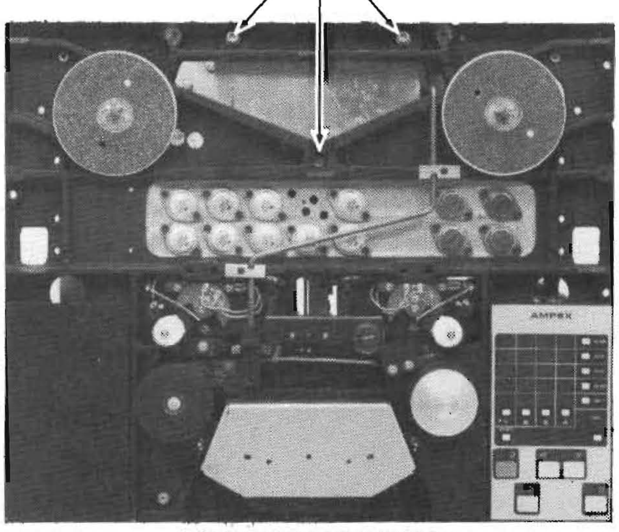



Figure 5-45. No or Poor Erase — Troubleshooting Flow Chart




BOTTOM VIEW OF RECORDER/REPRODUCER




TOP VIEW OF TRANSPORT

2966

**Figure 5-46. Power Supply Removal**

6. Disconnect electronic assembly harness connector P15 that connects to reel drive connector P15.

7. Disconnect control panel connector P11 from electronics assembly double-sided connector J11.

8. From the top of the transport, remove three 6-32 cap screws (Figure 5-38) that secure the electronics assembly to the transport.

9. From the bottom of the transport, slide electronics assembly chassis toward the supply reel and lift electronics assembly from the transport.

10. Remove electronics assembly rear cover panel (two screws).

11. Remove transport harness connector P10 from electronics assembly motherboard connector J10 to completely free electronics assembly from transport.

12. Reinstall electronics assembly in the reverse order of removal, being careful not to damage any cables (especially cable/connector P10).

**5-97. Capstan/Tach Assembly.** The capstan/tach assembly is assembled at the factory and must be replaced as a unit. To remove the capstan/tach assembly, proceed as follows:

1. Remove the head cover assembly and head assembly from the top of the transport.

2. Remove the transport front and rear overlay panels (eight screws) from the top of the recorder/reproducer.

3. Remove front and rear tach cover panels by removing two flat-head screws, one socket-head screw, and one banana plug shown in Figure 5-21.

4. Remove socket-head screw, lock washer, and flat washer that secure the Capstan Tach sensor PWA (Figure 5-20). (Note: Do not loosen or remove the bar holddown screw, shown in Figure 5-20, that secures the capstan sensor bar, or adjustment of the Capstan Tach Sensor PWA position will be required.)

5. Carefully lift Capstan Tach Sensor PWA from adjustment pin and the shoulder of PWA mounting post. Carefully turn PWA out of the way of the glass tach disc.

6. Loosen capstan-edit-knob setscrews (two), and remove knob.

7. Loosen the two capstan/tach assembly setscrews 1/4 turn. Carefully lift the capstan/tach assembly on the capstan motor shaft, then continue loosening the lower setscrew (nearest the tach disc) four full turns to remove the capstan/tach assembly from the motor shaft.

### CAUTION

IF TACH DISC NEEDS TO BE CLEANED, USE A SOFT LINT-FREE CLOTH OR KIMWIPE MOISTENED WITH WINDEX OR ISOPROPYL ALCOHOL. (FOR INSTRUCTIONS REGARDING THE CLEANING OF PHOTOPOTENTIOMETERS, LED's, OR ANY PHOTO SENSE DEVICE, SEE PARAGRAPH 5-6.)

8. Replace capstan/tach assembly and Capstan Tach Sensor PWA in the reverse order of removal. If a radial alignment mark is on end of motor shaft and on the capstan/tach assembly, line these two marks up before tightening the setscrews. This alignment position has been chosen at the factory for minimum flutter. Do not overtighten setscrews. (Correct setscrew torque is 1.8 ± 0.3 inch pounds.)

9. Before mounting overlay and tach cover panels, verify that Tach Sensor PWA is in the proper position by performing the following tests:

   a. With power off, unplug Reel Servo PWA No. 9 within the electronics unit. (This disables reel servo so that reel motors do not operate.)

   b. Apply power and press play pushbutton switch. Capstan should run at the selected speed.

c. Press stop pushbutton switch and observe if capstan quickly stops.

d. Press fast forward pushbutton switch and allow capstan to reach full speed, then press stop pushbutton switch. Capstan should quickly stop.

e. Press rewind pushbutton switch and allow capstan to reach full speed, then press stop pushbutton switch. Capstan should quickly stop.

f. If the system did not pass any one of the above tests, perform the Capstan Tach Sensor PWA position adjustment procedure given in this section under the heading *Capstan Tach Sensor,* paragraph 5-64.

10. Adjust the position of the tape peeler by performing the adjustment procedure given under the heading *Tape Peeler,* paragraph 5-75.

**5-98. Capstan Motor and Parts Replacement.** Besides the complete capstan motor, component parts that can be replaced are the motor brushes, flywheel and rotor assembly, capstan shaft assembly, and capstan motor bearings (Figure 5-47). It is not necessary to remove the complete motor to replace any of these component parts. The brushes are located within the rear cover. Note that the flywheel and rotor are not separable parts and therefore must be replaced as a unit.

The capstan rotor, rear cover, and brushes are manufactured by two different companies and these parts are not interchangeable on a given motor. Therefore, when parts are to be replaced, be sure the correct replacement part is used.

**5-99.** *Capstan Motor.* To replace the entire capstan motor, proceed as follows:

1. Remove the capstan/tach assembly as described under the heading *Capstan/Tach Assembly* in this section of the manual, paragraph 5-97.

2. Disconnect transport harness connector P18 that connects to capstan motor connector P18.

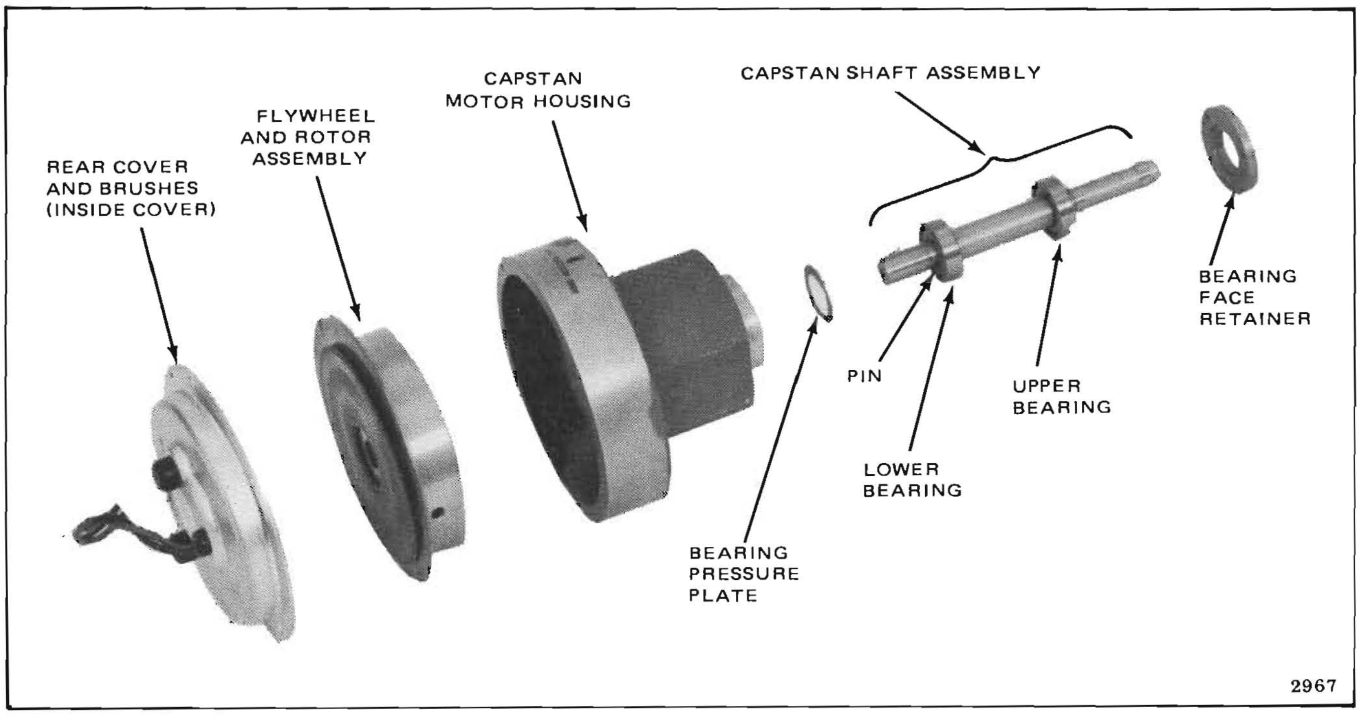



**Figure 5-47. Exploded View of Capstan Motor**

3. Disconnect control unit connector P11 that connects to electronics assembly connector J11.

4. Remove four capstan motor 10-32 holddown screws (Figure 5-48).

5. Carefully slide motor out bottom of transport, tilting motor as required to clear electronics assembly chassis.

6. Reinstall motor in the reverse order of removal with the flat on side of capstan motor housing facing the electronics assembly chassis.

**5-100.** *Capstan Motor Brushes.* Use the following procedure to replace the capstan brushes. The motor brushes (Figure 5-49) are attached to the inside of the capstan motor rear cover. Proceed as follows:

1. To permit more access space at the rear of the capstan motor, disconnect transport harness connector P18 that connects to capstan motor connector P11 that connects to electronics assembly connector J11.

2. Remove only the two screws and flat washers shown in Figure 5-49 that secure the capstan motor rear cover to the motor (not the plate screws).

3. Note that the permanent magnet within the rear cover tends to hold the cover to the

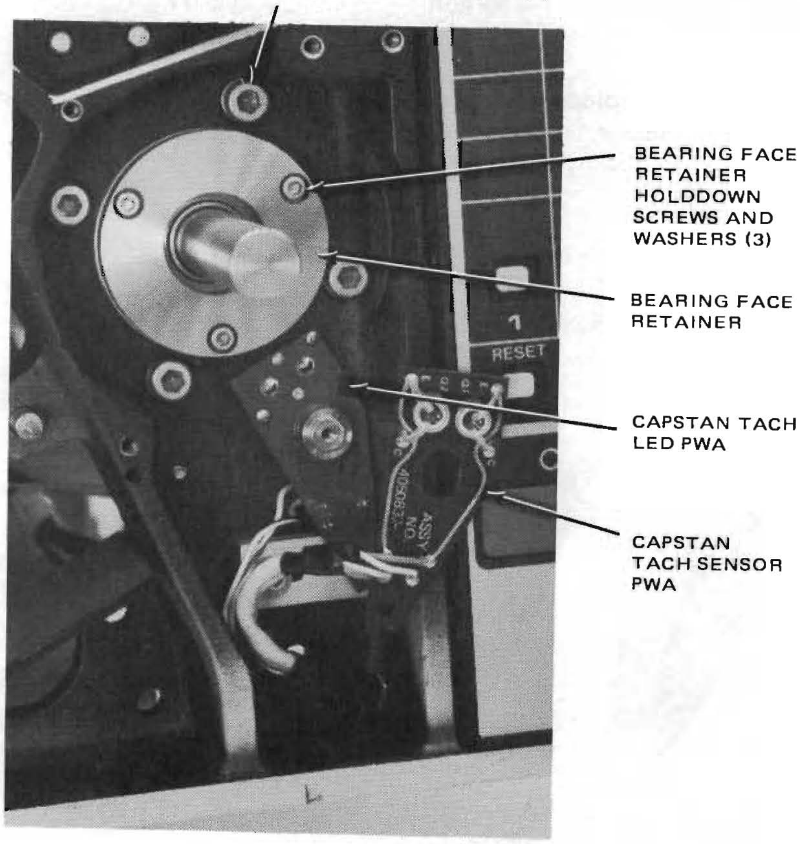



**Figure 5-48. Capstan Motor Removal**

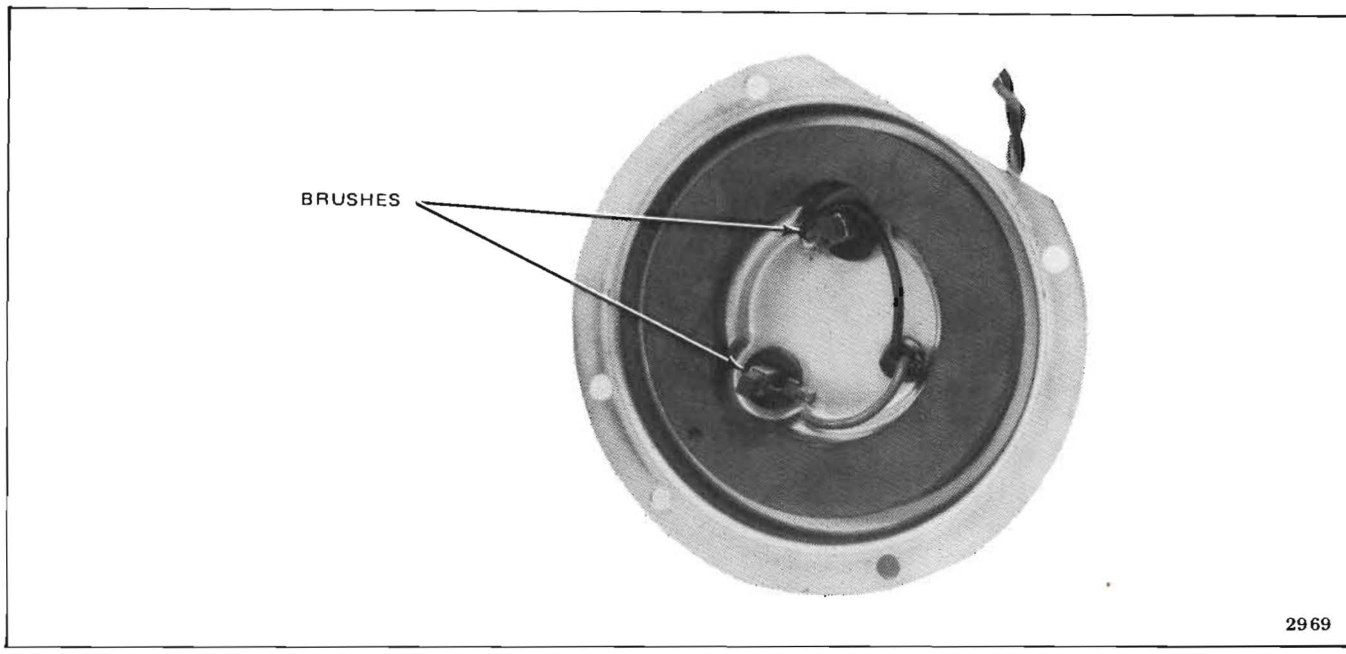



**Figure 5-49. Capstan Motor Rear Cover Assembly**

housing. Carefully pull rear cover from the motor.

### CAUTION

TAKE CARE TO PREVENT METALLIC PARTICLES FROM GATHERING ON THE PERMANENT MAGNET.

4. Unsolder each brush lead and remove brushes, taking care to save brush springs.

5. Install new brushes and springs. Before soldering brush leads, adjust lead length so that spring does not force brush from brush holder. While soldering lead, clamp brush lead with a long-nose pliers to prevent solder from entering braid.

6. Contour the brush ends by placing the rear cover face down on a sheet of 400-grit sandpaper placed on a hard flat surface. Rotate rear cover back and forth approximately 90° about five times. Clean all contamination from the magnet and then clean brush ends with isopropyl alcohol.

7. Reinstall rear cover onto motor using screws and flat washers removed in step 2.

8. Reconnect control unit connector P11 to electronics unit connector J11, and reconnect transport harness connector P18 to capstan motor connector P18.

**5-101.** *Flywheel and Rotor.* Use the following procedure to replace the flywheel and rotor assembly (Figure 5-47).

1. Perform steps 1, 2, and 3 of the preceding *Capstan Motor Brushes* replacement procedure (paragraph 5-100) to remove the capstan motor rear cover.

2. Remove the two hex-socket plate screws (Figure 5-50) that secure the 1/16-inch thick plate to the capstan housing (Figure 5-46).

3. Disconnect tach sensors connector J16 from electronics assembly connector P16.

4. Turn motor shaft to align hole in flywheel with hole in capstan housing. (Note: There are two holes in flywheel; one hole has a

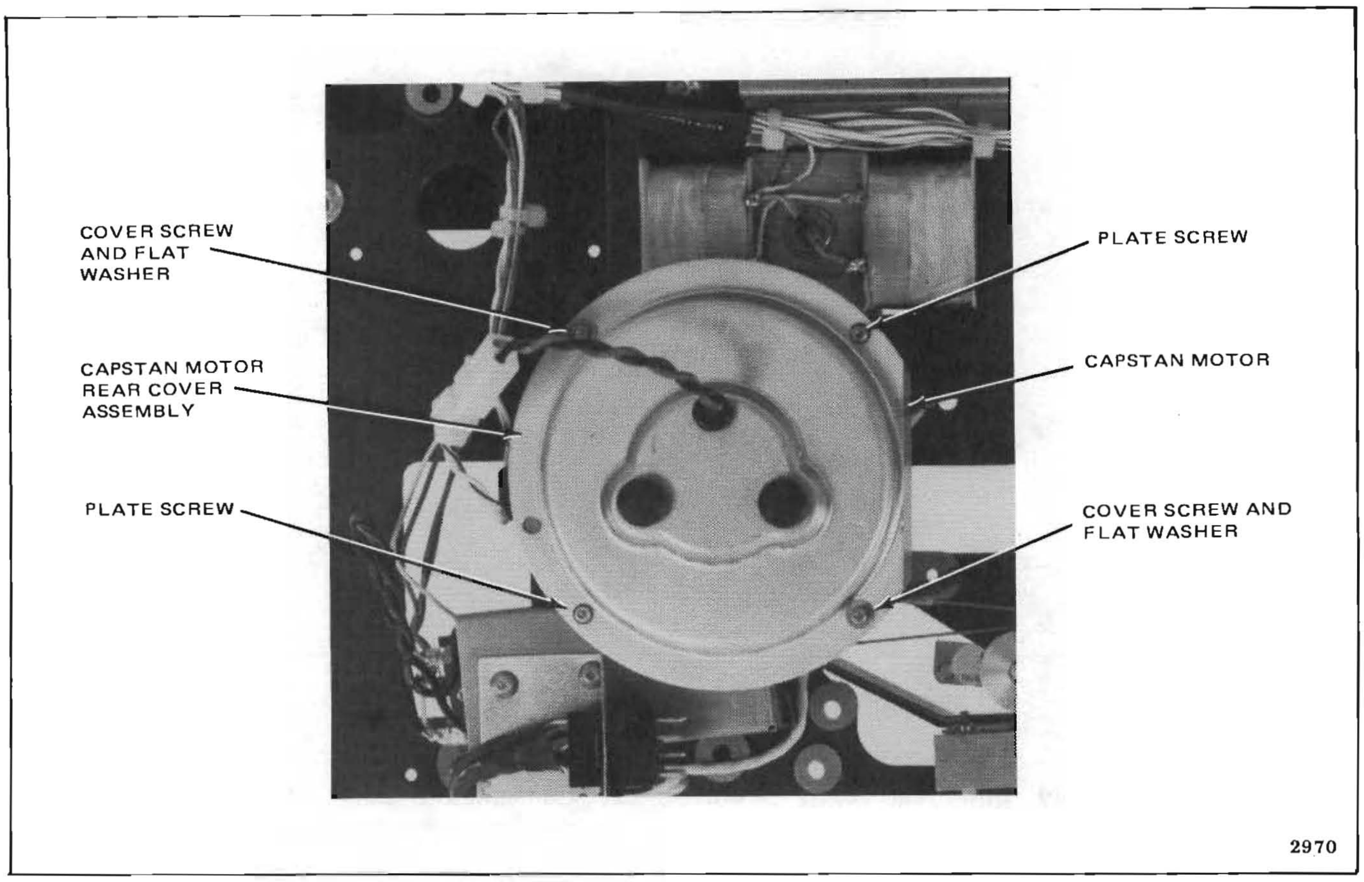



**Figure 5-50. Rear View of Capstan Motor Assembly**

setscrew and the other is a counterbalance hole.) Insert Allen wrench and loosen setscrew about five complete rotations.

5. While supporting flywheel and motor assembly with one hand, remove Allen wrench and carefully slide flywheel and rotor assembly off the shaft.

**CAUTION**

**DO NOT SCRATCH OR TOUCH PRINTED MOTOR SURFACE ESPECIALLY IN AREA WHERE BRUSHES SLIDE.**

6. Reassemble motor in the reverse order of disassembly. When installing flywheel and rotor assembly on shaft, be certain that key slot in flywheel engages with pin in capstan shaft before tightening flywheel setscrew.

5-102. *Capstan Shaft Assembly.* Remove the capstan shaft assembly from the front of the transport as follows:

1. Remove the capstan/tach assembly as described under the heading *Capstan/Tach Assembly* in this section of the manual, paragraph 5-97.

2. Disconnect tach sensors connector J16 from electronics assembly connector P16.

3. Turn motor shaft to align hole in flywheel with hole in capstan housing. (Note: There are two holes in flywheel; one hole has a setscrew and the other is a counterbalance hole.) Insert Allen wrench to loosen setscrew about five complete turns. Insert a spare Allen wrench in flywheel hole to maintain angular position of flywheel.

4. Remove bearing face retained (three screws and washers shown in Figure 5-48).

5. From the top of the transport, carefully pull capstan shaft assembly up and out of the capstan housing. Be careful to retain the three bearing compression springs that fit into holes in the spring retainer attached to the bottom of the capstan housing.

6. Prior to reinstalling the capstan shaft assembly, be sure that the three bearing compression springs are in the holes in the spring retainer inside the capstan housing.

7. Check that the bearing pressure plate shown in Figure 5-47 (looks like a large washer) is either resting on the springs or is held by grease film to the lower bearing on the capstan shaft assembly.

NOTE

Do **not** remove grease **coating within the capstan housing bore.**

8. Slide capstan shaft assembly into capstan housing so that pin in side of capstan shaft assembly is aligned with setscrew in flywheel.

9. Place bearing face retainer, removed in step 3, on top of upper bearing and push by hand against end of shaft to fully seat shaft in capstan housing and to compress bearing compression springs. If pin in side of capstan is not aligned with setscrew in flywheel, in order to engage key slot in flywheel, shaft will not fully insert into housing. (Approximately 20 pounds of force are required to fully compress the compression springs.)

10. After ascertaining that shaft is correctly installed and pin is engaged in slot in flywheel, install the three bearing face retainer screws and washers removed in step 4.

11. Tighten setscrew in flywheel against the capstan shaft assembly.

12. Rotate shaft by hand to check for freedom from rubbing or binding.

13. Reinstall capstan tach assembly as described under the heading *Capstan/Tach Assembly,* paragraph 5-97.

14. Reconnect tach sensor connector J16 to electronics assembly connector P16.

**5-103.** *Capstan Shaft Bearings.* With the use of proper tools, new bearings may be pressed onto the capstan motor shaft. If the proper tools are not available and the bearings need replacement, it is suggested that a new capstan motor shaft assembly (includes bearings) be installed (Ampex Part No. 4041264). The two ball bearings used are size R8, ABEC class 5 tolerance grade (Ampex Part No. 4200075) and are pregreased and ready for use. The bearings are double shielded, but not sealed, and are greased with Andok C grease.

To remove and replace the bearings on the capstan shaft, proceed as follows:

1. Remove the capstan shaft assembly from the capstan motor housing as described in the preceding *Capstan Shaft Assembly Removal* procedure, paragraph 5-102.

2. Prior to removing the lower bearing (Figure 5-47), remove the 0.062 flywheel drive pin from the capstan shaft.

3. Each bearing is removed by pressing the bearing off the shaft at the end closest to the bearing. Note: Removing the bearings usually causes permanent damage to the bearings and therefore they should not be reused.

4. Prior to pressing the new bearing on the shaft, coat the shaft with heavy grease to reduce friction while pressing the bearing on the shaft.

5. Press the new bearing on the shaft by pressing squarely against the bearing inner race *only.* If force is applied through the ball bearings, the

bearing will be damaged. Press the bearings fully against the shoulders of the shaft to obtain correct axial location relative to the shaft.

6. If the lower bearing (Figure 4-47) was replaced, reinstall the 0.062 pin removed in step 2. Use an adhesive such as Loctite to secure pin. Be sure pin is fully bottomed in hole drilled in side of shaft.

7. Protect capstan shaft assembly against dirt and mechanical damage until reinstalled into capstan motor housing. Reinstall capstan shaft assembly as described in the preceding *Capstan Shaft Assembly Removal* procedure, paragraph 5-102.

**5-104. Reel Drive Motors and Brush Replacement.** Besides the complete reel drive motor, the only parts that may be replaced on a motor are the motor brushes. The motors are supplied by several vendors and may be used interchangeably in a supply or takeup motor position. However, the brushes are not interchangeable and the correct brush for a given motor must be used.

**5-105.** *Reel Drive Motor Replacement.* To remove and reinstall a supply or takeup reel motor, proceed as follows:

1. Remove the power supply by following the instructions given under heading *Component Replacement Procedures* in this section of the manual, paragraph 5-94.

2. Disconnect the appropriate reel drive motor connector P17 (takeup) or P19 (supply).

3. Remove and reinstall reel motor by following the instructions given for *Turntable Repositioning for Reel Size* (paragraph 2-22) given under the heading *Initial Adjustments* in Section 2 of this manual.

4. Reconnect reel motor connector P17 (takeup) or P19 (supply).

5. Reinstall power supply and reconnect power supply connectors P1 and P2.

6. Reinstall transport upper overlay panel.

**5-106.** *Brush Replacement.* The two motor brushes seldom wear out; however, a brush may chip or become noisy and therefore need replacing.

Proceed as follows:

1. If the brush that needs to be replaced is facing the power supply, remove the power supply by following the instructions given under the heading *Component Replacement Procedures* in this section of the manual, paragraph 5-94.

2. To remove a brush, use a large bladed screwdriver and unscrew the motor endplug (Figure 5-51). The brush has a spring attached which maintains pressure against the motor commutator. Slide the old brush out of the retaining hole in the motor.

3. Clean the new brush with isopropyl alcohol and install in the motor.

4. Secure new brush and spring with endplug removed in step 2.

5. If power supply was removed, reinstall in the reverse order of removal.

**CAUTION**

**A NEW BRUSH MAY SQUEAK UNTIL THE MOTOR HAS BEEN RUN LONG ENOUGH TO SEAT THE NEW BRUSH TO THE COMMUTATOR. DO NOT APPLY ANY LUBRICANTS TO THE BRUSH.**

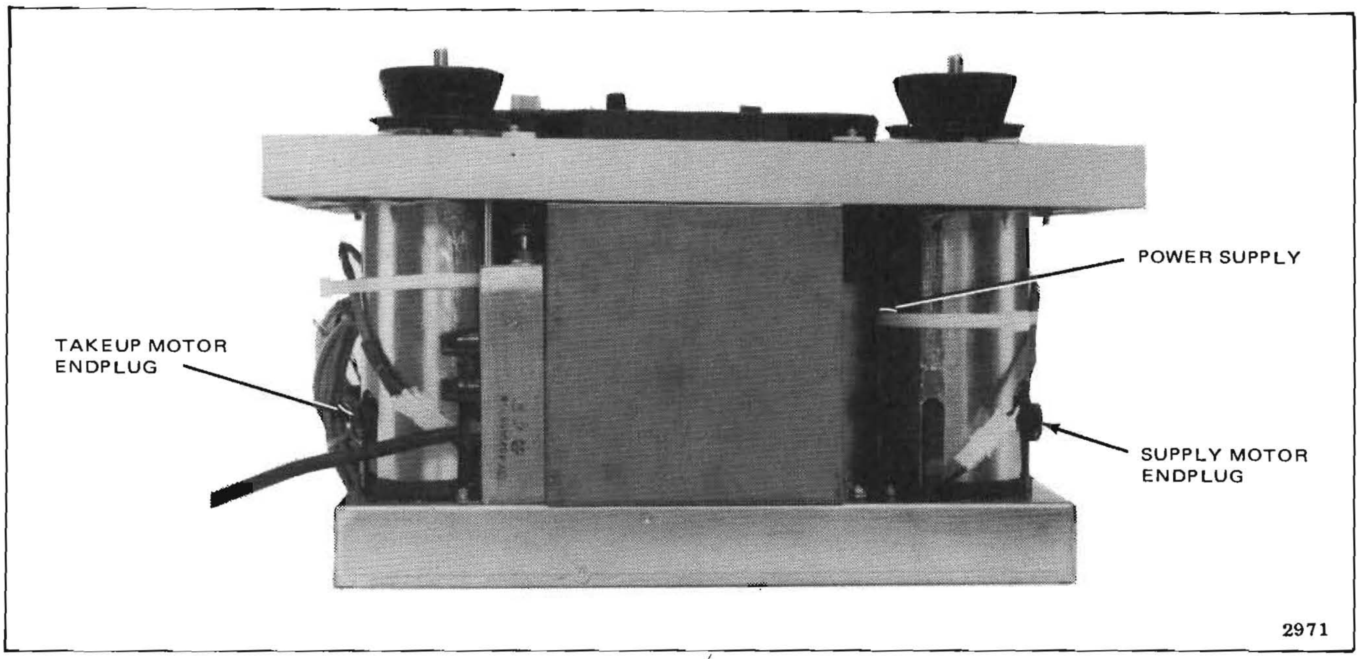



Figure 5-51. Reel Drive Motor Brush Replacement, Rear Side View of Transport